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The Delaware River Basin
A Home Rule Program for the Development of Its Resources

By James H. Allen

THE Delaware River Basin—A Home Rule Program for the Development and Conservation of its Resources. I wonder what your reaction was when you read this title. Did the reference to "A Home Rule Program" have any particular significance to you? I hope it did because in my mind, and I trust I shall be able to convince you, this is the most important aspect of my discussion. A program for the development of the resources of the Delaware River Basin is desirable, is necessary. But over and above all, if we in this nation are going to continue to operate upon a truly democratic basis, it is essential that this and many other enterprises be *home rule* programs.

In support of this opinion I am going to refer to portions of an article in the September, 1943, issue of *Reader's Digest,* written by one of our most distinguished Congressmen. The description "distinguished" is particularly fitting in this case because, strangely, the author is neither from any of our states here represented, nor is he, as far as I know, connected with the movement in which the Commission I represent is participating, nor a member of the minority party in Congress, as you might suspect if I permitted him to remain incognito. And yet, in my judgment, he expresses our way of thinking on this subject of home rule, perhaps better than we do ourselves. I am sure, coming as it does from a source far removed from our locality, he does it more effectively. I give you the words of wisdom and counsel of Hatton W. Summers of Texas.

Why is it, he asks, that in this land where everybody proclaims his devo-

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A paper presented on October 15, 1943, in Philadelphia, at the joint meeting of the Four States Section and the Pennsylvania Water Works Operators Association by James H. Allen, Chief Engineer, INCODEL, Philadelphia, Pa.

tion to democracy, representative government is withering before our eyes?

What Is Happening To Democracy?

He then goes on to explain what the forces are which have been acting to destroy the principle of local self-government. Two are uppermost. Neither of them was brought on or made necessary by the present war. They have been in action for the past 50 yr. At first they grew in slow easy stages. Then, paraphrasing Summers, the last war gave them a big push, the postwar dislocation which followed accelerated the trend, the great depression raised the movement to avalanche proportions, and the present war seems to be completing the job.

One of these forces is the inclination on the part of the people to invite the federal government to intervene in all of their problems. Said Summers:

"Every town and state, every trade association and trade union, every class and group and desperate minority brings its problems to Washington. And Washington is gladly accepting that responsibility."

Then Summers warns that the promoters of centralization are resorting to the exercise of another force, one against which no constitutional barrier will ever stand—the control of purse strings. As to this power, he remarks:

"By making the units of state government financially dependent on the federal government, that government is acquiring the power to control the units of state government. When this is fully consummated, the sovereignty of the state governments will be liquidated.

"In weakening the states we weaken the whole fabric of free government. The inescapable price of free government is that we exercise it. The most destructive force in the world is nonuse. If we do not use our powers of self-government in the states we will awaken one day to find that self-government has passed irrevocably out of our hands.

"Government is exercised best in the local community. There the problems are perceived with greater clarity because they are close to the people and on a scale within their grasp."

Summers concludes his article with the following admonition:

"The states must resume the status of responsible sovereign agencies of general government or democracy cannot live in America."

A Home Rule Program For the Delaware River Basin

You no doubt now understand why I stated, in opening, that the most significant aspect of my subject is not that there is a program for the development of the resources of the Delaware River Basin. The important fact is that the representatives of the people of the states in which the Delaware River Basin is located are, and have been for a long time, of the same mind as Congressman Summers. They refuse to believe that the federal government can do a better job than their local state governments in formulating a program for the development of the Delaware River Basin. The people here want, and are developing, their *own home rule* program. And except when forced by circumstances beyond their control or in cases of a national emergency such as the present war, will they, in any respect, relinquish to

the national administration their responsibility and power to do this job. The manner in which they are handling the problems within the interstate Delaware River Basin should set an example which may well be followed by many other states in turning the tide toward the sensible resumption of state sovereignty.

We who are pioneering in this movement for better home rule government

among the states through the medium of interstate co-operation are convinced that the type of future government in this country will be determined to a great extent upon the success or failure of our efforts. If successful, we will have helped tremendously in bringing self-government back to the people at home where it belongs. If we fail, we see no alternative other than further concentration of authority and governmental power, with all its potential dangers, in Washington.

Federal Interest In Basin

Some of you may be saying by now that I am raising a great fuss about a lot of nothing. Those of you who are doing so may even agree with my thesis up to the present but, for the life of you, you cannot see why I am so concerned. You probably are saying that as far as you know the federal government is not threatening to take over the Delaware River Basin.

Perhaps not. We hope not. But there is no way to be sure of this. We do know that in 1933 the federal administration acquired control of the Tennessee River Basin and has been running things there since. We do know that in 1937 attempts were made in Congress to blanket the entire United States with similar river authorities. We do know that in many sections of the country tremendous sums of national money have been spent upon purely local public works. We do know that many bills have been introduced in Congress for federal control of stream pollution. We do know that a federal agency has suggested that the Delaware River should be utilized for the production of hydroelectric power. We do know that this same federal agency has recommended that Congress should authorize it to construct a ship canal across the State of New Jersey between Trenton on the Delaware River and New Brunswick on Raritan Bay.

Some of these projects may be desirable and advisable, and their construction may be the proper function of the federal government. Some, we believe, are ill-advised and objectionable.

All, we maintain, should be analyzed carefully by the states which would be affected. For those which are advisable a policy for their construction, under which the rights of the states would be properly protected, should be adopted and followed. The surest way to accomplish this is to prepare your *own home rule* program. That is what the states in which the Delaware River Basin is located are doing.

Incodel Organization

The machinery through which they are tackling this job was constructed in 1936 when the states of New York, New Jersey, Pennsylvania and Delaware organized and created the Interstate Commission on the Delaware River Basin, now popularly known by its nickname, *Incodel*. The Commission is composed of twenty members, five from each state. Of each group of five, one member is from the Senate, one from the House of Representatives, one is the Chairman or Director of the State Planning Board, if such agency exists, otherwise an official of some other department of the state, and the fourth is an administrative official representing the Governor's office. The fifth member from each state is a member at large who is selected by the other members of the Commission.

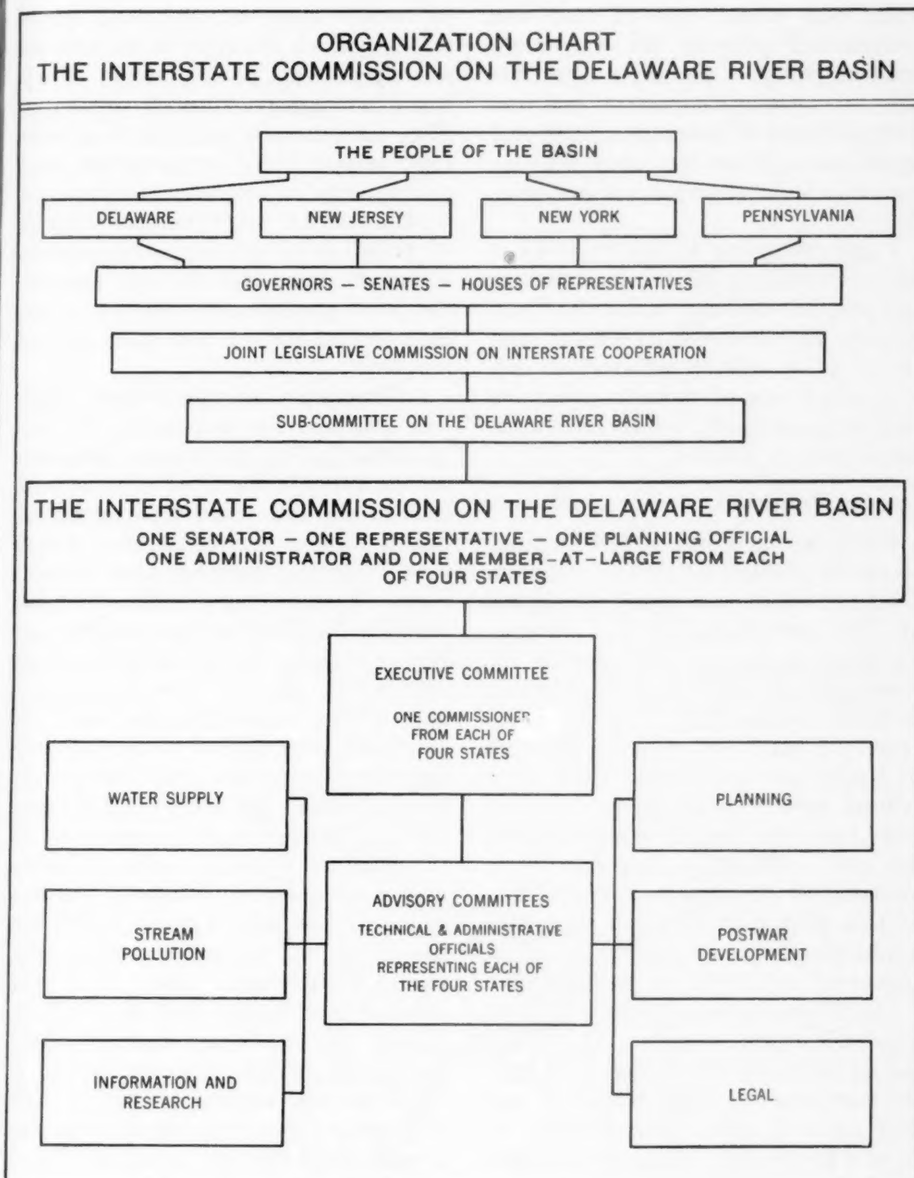
The Commission operates with a small staff on an annual budget obtained from equitably apportioned appropriations from the four participating states. In the conduct of its work it has access to, and avails itself of, the combined facilities and technical resources of the existing agencies of the states' government.

General Functions

The broad general function of the Commission is to develop and assist in securing the execution of co-ordinated and practical policies and programs for the conservation and wise use of the water and other natural resources of the Delaware River Basin. It seeks to accomplish this objective efficiently and economically, and without fanfare. In no way does it seek to supplant or supersede any of the functions of existing state agencies, legislative, administrative or executive. Instead, its purpose is to co-ordinate, assist, supplement and strengthen each of these branches of state government.

The work of this joint state governmental agency—*Incodel*—is concerned with problems of interest to many departments and agencies of the participating states and of the federal government and also to private business and industrial organizations. Because of this, one approach to its broad objective might have been to start upon an all-out survey of the basin on the theory that such a study was a prerequisite to the satisfactory solution of each major problem, regardless of its importance and urgency. Such an approach would have involved the spending of large appropriations and, no doubt, would have been spectacular.

The Commission, as a matter of fact, was urged to follow this procedure, significantly perhaps, by representatives of a federal board who also proposed that their agency should participate in the work. *Incodel*, however, could not agree that this approach would be effective in the long run. Therefore, instead of embarking upon such a blanket survey the


ORGANIZATION CHART
THE INTERSTATE COMMISSION ON THE DELAWARE RIVER BASIN
THE PEOPLE OF THE BASIN
DELAWARE
NEW JERSEY
NEW YORK
PENNSYLVANIA
GOVERNORS — SENATES — HOUSES OF REPRESENTATIVES
JOINT LEGISLATIVE COMMISSION ON INTERSTATE COOPERATION
SUB-COMMITTEE ON THE DELAWARE RIVER BASIN
THE INTERSTATE COMMISSION ON THE DELAWARE RIVER BASIN
ONE SENATOR — ONE REPRESENTATIVE — ONE PLANNING OFFICIAL
ONE ADMINISTRATOR AND ONE MEMBER-AT-LARGE FROM EACH
OF FOUR STATES
EXECUTIVE COMMITTEE
ONE COMMISSIONER
FROM EACH OF
FOUR STATES
WATER SUPPLY
PLANNING
ADVISORY COMMITTEES
TECHNICAL & ADMINISTRATIVE
OFFICIALS
REPRESENTING EACH OF
THE FOUR STATES
STREAM
POLLUTION
POSTWAR
DEVELOPMENT
INFORMATION AND
RESEARCH
LEGAL

results of which probably would have been set forth in a voluminous report which few would care to read, the Commission adopted the far more practical policy of making a direct attack on obvious, important and urgent problems of interstate or regional significance. That this approach has been wise and effective is without question.

I am not going to try to make a report to you on all of the activities and program items to which the Commission has devoted its efforts and energies. It will be sufficient to discuss only a few of those in which the federal government, to say the least, has shown an interest.

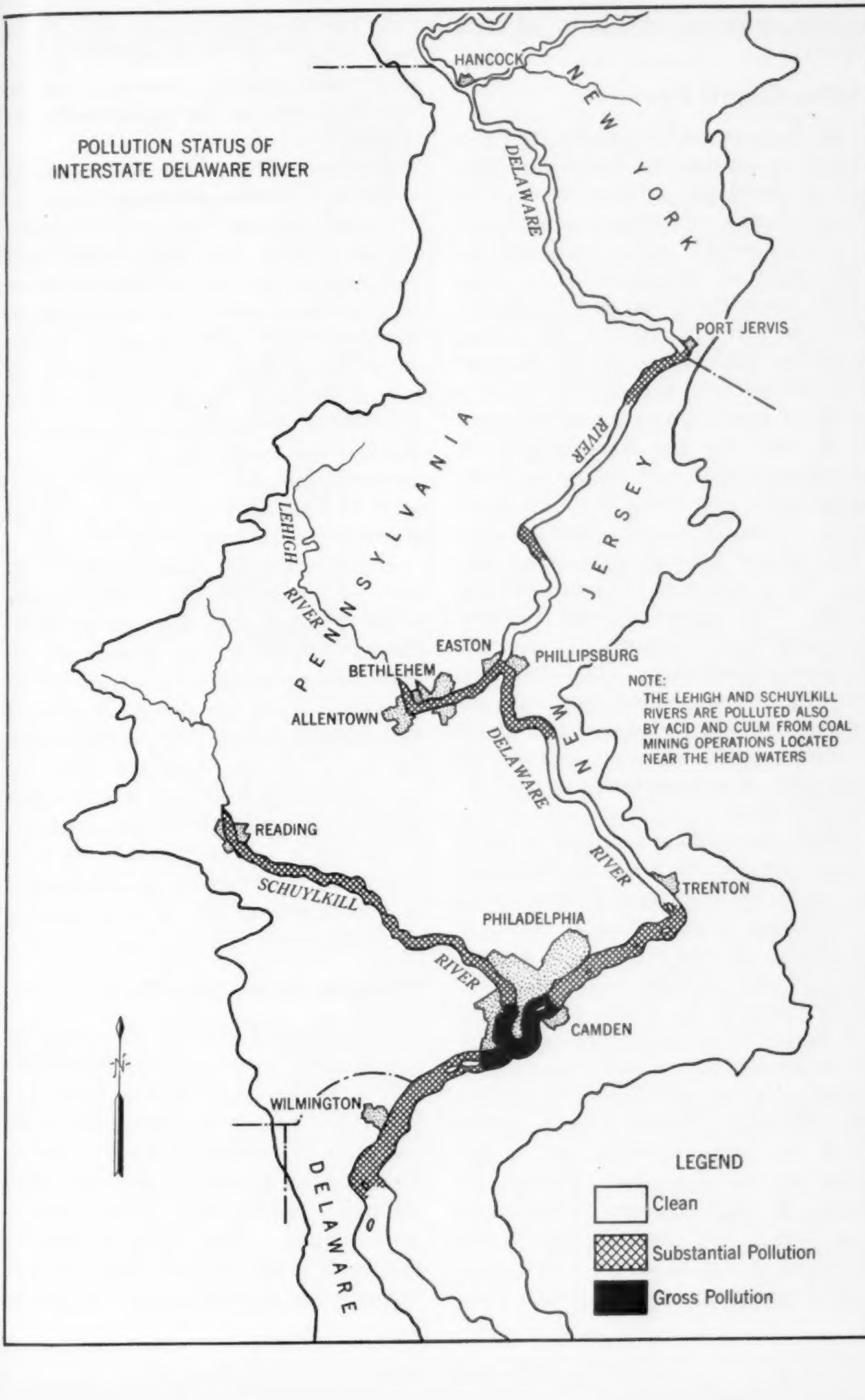
Stream Pollution

First, let us think a few minutes about the problem of stream pollution. I believe all of you recall the efforts of the centralizationist to influence Congress to pass a bill whereby the power and authority to enforce stream pollution measures would be taken from the hands of state departments of health and placed into those of a federal agency with power to bring suits into the federal courts against any city or industry alleged to be in violation of the proposed federal law. If this wasn't an effort to usurp the sovereign powers of state government, please tell me what you would call it.

Our Commission opposed this move, and opposed it strongly. It did not do so, however, by crying—you can't do that here. It did more. It said you can't do that here because we have a better way. Then it proceeded to show what that better way is.

Being an interstate stream and the joint property of four owner states, the Delaware River might have been looked upon by these nationalists, as so often is the case, to belong to none of them. However, the four states through which the river flows took an entirely different point of view. They would not agree with such reasoning. They take the position that it is their joint responsibility to formulate, and subsequently to execute, a policy and a plan for the correction and control of pollution in this interstate stream. They are doing this through *Incodel,* the joint governmental agency which they created for this and other related purposes.

In operation the procedure which was followed for developing the cooperative policy for stream pollution control brought the chief engineers of each of the four state departments of health around the conference round table. By this method, after several years of study, they evolved a plan whereby the River and its contributary drainage basin was divided into four sections or zones. For each zone, appropriate, reasonable and uniform standards were agreed to and adopted regarding the treatment of sewage, industrial wastes and other polluting material. The agreement formulated in this manner thereupon was incorporated into uniform, reciprocal legislation. It has been ratified and made law in each of the participating states except Pennsylvania where it is now pending and, we are confident, will be passed in the near future. This method, I believe you will agree, is the *home rule* method of dealing with this water resource problem. Can any one maintain that an agency in Washington could handle this problem as well as was done by the engineers of the state governmental agencies who have been devoting their lives' work


POLLUTION STATUS OF
INTERSTATE DELAWARE RIVER
HANCOCK
NEW YORK
DELAWARE
PORT JERVIS
RIVER
PENNSYLVANIA
JERSEY
LEHIGH
RIVER
EASTON
PHILLIPSBURG
BETHLEHEM
ALLENTOWN
NOTE:
THE LEHIGH AND SCHUYLKILL
RIVERS ARE POLLUTED ALSO
BY ACID AND CULM FROM COAL
MINING OPERATIONS LOCATED
NEAR THE HEAD WATERS
DELAWARE
NEW
READING
RIVER
TRENTON
SCHUYLKILL
PHILADELPHIA
RIVER
CAMDEN
N
WILMINGTON
DELAWARE
LEGEND
Clean
Substantial Pollution
Gross Pollution

to the pollution problems of this region?

Hydro-Electric Power

Let us next analyze briefly the question as to whether the Delaware River can be developed advantageously for the production of hydro-electric power. A congressional report published in 1932 sets forth the results of a survey of the river which had just been completed at that time by the U.S. Army Engineer Office. The report advances a proposal for the construction of a series of reservoirs in the upper basin to be used for the dual purpose of providing a source of future or additional water supply for the New York City, Philadelphia and northeastern New Jersey metropolitan areas and for the production of hydro-electric power. The engineers stated that federal participation in such a project did not appear justifiable. They also, very properly, recommended that any development of the Delaware River above Trenton should be controlled by an interstate agency representing the interested states.

While the policy for joint control of the river by the states as suggested by the Army Engineers is logical, the Commission realizes that it does not necessarily represent the view of present or future national administrations. With the aim, therefore, of knowing the facts in order to be prepared to appraise intelligently possible future proposals which might involve or lead to the establishment of a federal authority in the Delaware watershed, as was done in the Tennessee Valley, the states, through *Incodel,* made their *own home rule* investigation of the situation in this basin.

It found among other things that:

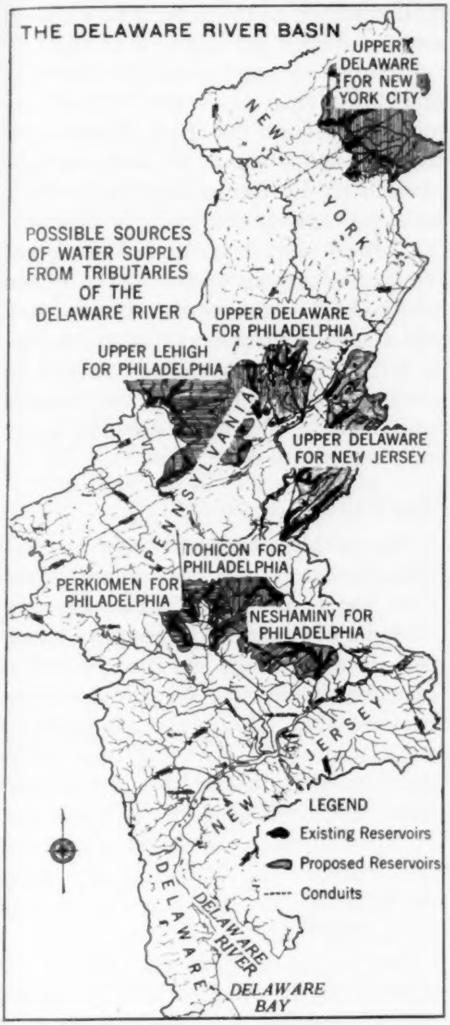
1. The development of the Delaware River for hydro-electric power *alone,* whether under private or public control, would not be economically attractive.

2. That while power developments *might* be combined advantageously under public control, with a joint water supply project for Philadelphia and northeastern New Jersey, there appears to be no need, reason or inclination on the part of the states involved to develop such a joint water supply in the near future, and the probability of its ultimate development is questionable. As long as these are the facts, suggestions for the wholesale development of the Delaware River for water power have no merit whatever.

The Commission trusts that the results of this *home rule* study disposes of the possibility of any movement on the part of the federal government to undertake to harness the waters of the Delaware Basin for the production of hydro-electric power. If, in the future, the use of the waters of the River for this purpose in conjunction with other uses should become advisable, the states in the Basin believe they will be fully competent to recognize the advantages of such a project and to be a party to its development and operation.

The New Jersey Ship Canal

The proposed federal construction of a ship canal, costing at least $200,000,000, across the State of New Jersey between Trenton on the Delaware River and New Brunswick on Raritan Bay is another project to which the four states through *Incodel* have given careful consideration. The joint interest of the states in this project concerns particularly the probable effect of the op-



eration of the canal upon the quality of the water in the Delaware River. Below Trenton, approximately 2,500,000 persons, in Bristol, Burlington, Philadelphia and Chester, get their municipal water supply from the Delaware. Hundreds of important industries also depend entirely upon the River for their source of water. If the canal were constructed as we know it now to be proposed, at least 150,000,000 gal. of water a day, and probably a much greater quantity, would be diverted from the river during periods of summer drought for its operation. To our knowledge no provision was being made to get this water from a stored supply. Consequently its taking during periods of summer drought would have a serious and damaging effect. The reduction of stream flow would increase the pollution load in the river, aggravate salinity conditions in the lower estuary, and generally cause an appreciable deterioration of the quality of the water in the river for municipal and industrial uses.

Furthermore, the claim made in this report that locks at each end of the canal could be so constructed and operated as to prevent the admission of any intolerable amount of salt water into the Delaware River from Raritan Bay is questionable. As far as we know no method yet installed has operated successfully in this respect for a canal of the size and type under consideration.

In view of the above circumstances, and because the canal, in any event, could not be built for use during the present war, *Incodel* has taken the position that, as presently proposed, the project should not be authorized. It further maintains that before authorization, opportunity should be afforded the states and regions affected to suggest such revisions as may be necessary to overcome any features of the proposal which may be unreasonably inimical to the interests of the states directly affected.

We are sure that consideration is being given to the objections raised by *Incodel* pursuant to its *home rule* analysis of this federal proposal. We are confident that the construction of the

canal, as its design was last made known to us, will not be authorized by Congress.

Water Supply Diversion Projects

Perhaps the most troublesome and difficult problem which the Commission has tackled has been to devise rules and conditions under which each of the states may construct and operate water supply projects located in the basin but from which the water would be transported for use into areas lying outside of the Delaware watershed.

New York City is constructing such a project now. Under the authority of a decree handed down by the U.S. Supreme Court in 1931, it has been given the right to divert 440 mil.gal. of water a day from the Delaware watershed. The first stage of this development is under construction.

It is probable that New Jersey will undertake a similar type of development sometime in the future to meet the needs of its northeastern metropolitan area. Several proposals have been advanced for this purpose, among them one which provides for the diversion of 150 mil.gal. of water daily from the natural flow of the Delaware River at a point about 20 mi. above Trenton, N.J.

The city of Philadelphia also is confronted with a water problem. The probabilities are that this city will wish to obtain its future supply from tributaries of the Delaware River located in the upland watershed area in Pennsylvania. Such a project would involve the diversion of approximately 500 mil.gal. of water daily from a considerable stretch of the Delaware River.

You all can understand that unless such projects are operated under suitable conditions whereby there would be no diminution of the natural flow of the streams during periods of low run-off, substantial damages would be imposed upon lower riparian owners. The Commission, through the chief engineers of the responsible water resources agency of each of the four states, has made a most painstaking study of this problem. The result has been complete agreement among them upon a policy under which each state in the future may make such developments as are necessary to meet the reasonable needs of its people and, at the same time, protect and improve conditions for the lower interests in the river.

The Salinity Problem

The problem created by the tremendous increase in the salt content of the river water in the tidal estuary between Philadelphia and Wilmington during periods of drought and low run-off is extremely serious to this highly industrialized area. Investigations made by our Commission show that these salinity invasions increase the cost of muicipal and industrial water treatment by approximately $400,000 a year, on the average. In extremely dry years the increased expense may run as high as $2,000,000.

Incodel, in co-operation with the industries in the affected area, has given much attention to this problem. A practical solution lies in the construction of supplementary sources of industrial water supply to supplant the deteriorated river water during periods of high salinity. The construction of such works is an early "must" in the postwar development of the Delaware River region.

Water Conservation

Early in May of 1942, *Incodel* was asked to undertake the planning and

management of a Water Conservation Campaign in the Philadelphia Metropolitan District.

The war needs of the five-county area which include the District were increasing at such an alarming rate that unless "water-as-usual" habits were curtailed a serious breakdown seemed inevitable. It was obvious, however, that the situation did not rest in the hands of the management of the several water supply agencies serving the District but rather upon the degree of co-operation on the part of the 2,500,000 users of water to the pleas, "Don't Be A Drip!" and "Use Water Wisely."

The patriotic response of the citizens to the request to conserve water for war and essential civilian needs and services was most encouraging. Through them, the District not only met the increased demands brought on by the war but did it with 20 mgd. less than was used the previous year.

Postwar Preparedness

I cannot conclude my paper without having you know that our Commission too is preparing for peace. I shall do this by quoting briefly from our last annual report, issued in June of this year. In a section headed "Postwar Preparedness," the Commission says:

"At the moment no task is more vital than winning the war. But next in importance is the necessity of being prepared for the period of reconstruction that is to follow. The states of the Delaware River Basin have clearly recognized this mandate for postwar preparedness and are now engaged on many fronts in this campaign."

We agree and endorse the slogan adopted by the Inter-association Committee on Water and Sewage Works Development—"Blueprint Now." Our Commission already is actively engaged on a program to get its governmental subdivisions to do this very job. But as with all our other activities, we want and shall strive to see that this work will be done on a truly *democratic* and *home rule* basis.

In the article entitled "Computation of Flows in Distribution Systems," by Weston Gavett, which was carried in the March 1943, issue of this JOURNAL, an error in the text which appears on page 271, has been found. The closing sentence in the paragraph at the top of the right-hand column of this page should read as follows:

"A further trial e comes as close as practical with the slide rule, the loss to F through pipe 7 being 24.9 ft. and to F through pipe 5, 25.3 ft."

Water Engineering After the War

By N. A. F. Rowntree

It is accepted generally that the change in the mode of living for everyone at the end of the war should take place, as far as possible, in an orderly manner so as to avoid the development of dangerous and undesirable tendencies. This being a "total" war, the cessation of the war will involve "total" changes affecting in one way or another every citizen, industry and institution in this and most other countries.

The necessity of planning during the war for the difficult postwar period having been envisaged, it becomes desirable that each society or group of persons representative of the nation's life should consider together the way in which their activities are to be directed when the war ends. Thus there are good grounds for water engineers to study the history and development of their undertakings and to discuss and fix in their minds the best ways in which their duties can be fitted into the general scheme of reorganization. Much discussion has already taken place in all walks of life on postwar planning, but, owing to the large number of unknown factors involved, careful planning is not an exact science, and has consequently given rise to many differences of opinion, and will no doubt give rise to many more. The position is not made easier by the fact that the Government, no doubt unwilling to state a detailed policy which might be reversed after a general election, has been unable to set out definitely many of the important basic principles and policies on which planning must be founded.

The Prime Minister, in his broadcast in March 1943, did, however, enumerate very clearly certain hypotheses which must be borne in mind when considering the state of affairs at the end of the war and the four following assumptions are important to the subject of this paper:

(*a*) The wars in Europe and the Pacific are unlikely to end simultaneously.

(*b*) The European war may be concluded before Japan is finally overthrown.

(*c*) Essential reconstruction will begin immediately on the ending of the war with Germany and Italy.

(*d*) A transition phase of four years' duration is proposed as the first

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A paper presented before a meeting of the Institution of Water Engineers (British) by N. A. F. Rowntree, B.Sc., Assoc. M. Inst. C. E., and published in *Water and Water Engineering* for November, 1943. Republished here by permission of the author and the prior publisher, through the co-operation of the British Library of Information, N.Y. Made available to North American water works engineers as evidence of the international tendency to plan now for postwar public works.

installment of the reconstruction period, in which essential, and to some extent, temporary arrangements will be made and carried out.

These four probabilities are of considerable importance when considering the position of water supply after the war, and particular care must be taken to distinguish, where necessary, between such projects as belong to the "Four-Year Plan" and those which are more concerned with permanent policy.

Before the war is over, definite plans can be made for the four-year reconstruction period, and these plans will no doubt be subject to considerable control by the central government. Permanent planning must be based on policies approved by the electorate after the war, and it can in general only be assisted now by the accumulation of information and opinions which will help towards the satisfactory execution of such policies.

The Water Engineer's Concern With Postwar Developments

Like every other inhabitant of the country, water engineers are concerned and interested in the discussions on, and sometimes ambitious proposals for, the reconstruction of this country after the war. That some reconstruction is inevitable is obvious from the destruction and dislocation which the war has caused, and the extent to which such reconstruction is to be carried is a matter of vital interest. However, it must be continually remembered that, because a state of affairs or organization existed in 1939, it should not necessarily be condemned on that account alone, for it is the responsibility of planners to draw from the pool of experience and history and to amend it ruthlessly where required to suit altered conditions.

Apart from a general interest in planning, water undertakers have particular and specific responsibilities to insure that their organizations can fit in with future conditions. Again, water engineers, particularly those who have also managerial duties, are widely interested in all the future aspects of the water supply industry in addition to the very special technical matters on which they alone can advise.

This paper, being presented to the Institution of Water Engineers—the only organization in the country solely concerned with water engineering—deals principally with the technical aspects of postwar reconstruction, as the broader point of view is already being exhaustively considered elsewhere. The technical aspects themselves constitute an extremely important subject, and the following remarks can be little more than a brief survey, of which many of the individual sections warrant further special study.

Control and Administration of Water Undertakings

A considerable amount of political interest is being taken in the ownership and control of public utilities, although the agitation for public ownership of utilities does not seem to be based on any dissatisfaction with the engineering aspects of the undertakings. Any new legislation for transfer of ownership or control of water undertakings would be bound to affect water engineers in the performance of their duties. Various trends of thought on this matter have been expressed, and, although the necessity for very considerable alterations has yet to be proved, an examination of the technical

aspects of the changes which are envisaged is worth while.

(*a*) *Control of Existing Undertakings by the Central Government*

The idea of the control of water undertakings by the Central Government has been encouraged as being a natural result of regional control by government departments during the war, and assumes this regional system to be worthy of extension. This is by no means a unanimous opinion, and careful consideration should be given to the implications of such a policy, particularly with regard to the extent and possible duplication of responsibility. The proposal for a "Water Grid," on the basis of the Grid Scheme operated by the Central Electricity Board, would seem to be in the category of control by the Central Government. In spite of the number of years during which the idea of a water grid has been put forward, it has so far failed to capture interest on a large scale. On the other hand, consideration may be given to the Water Grid system operated under control by the Central Government or more locally in the form of networks obtained by the methods described in (*c*) and (*d*) hereafter. After all, any water undertaking is a water grid; the point at issue is its size and control.

(*b*) *Control of all Undertakings by Existing Local Government Authorities*

This would be the completion of a gradual process and would not make a great deal of difference to the purely engineering aspects of water supply, with one important exception. The existing boundaries of local authorities are not determined according to suitability for water supply purposes, particularly in rural areas and among groups of adjacent towns, and it would be manifestly impossible and undesirable to break up, for the purpose of public ownership, an existing water company supplying a number of authorities. This one fact would seem to rule out such a scheme, as alterations on this basis would be an example of planning for planning's sake, and would confer no real benefits.

(*c*) *Grouping of Undertakings*

This procedure has many notable and successful precedents, and may take the form of joint water boards on which the various local authorities concerned are represented; or perhaps smaller replicas of the Metropolitan Water Board (London) may be preferable in some cases. The most important aspect of this problem for an engineer is to determine the extent of the Water Board groupings in relation to areas of supply, population and resources within which it is possible to maintain efficient operation.

(*d*) *Bulk Supply Authorities*

In some cases it may be more economical to consider the formation of large bulk supply undertakings, located according to the water resources of the country, which will supply water to a number of distributing undertakings in their districts, as in the case of the Derwent Valley Water Board. An attraction of this scheme is that water could in this way probably be conveyed more economically through long distances from the wetter parts of the country to the drier areas, and might possibly help to simplify rural schemes. This scheme, however, should not be made an opportunity for each local authority to take over the distribution of water within its area. As a rule very little would be gained, other than some

sentimental satisfaction, and in most cases much would be lost in efficiency. It would, in fact, be a reversion towards the parish pump and, if it should be thought fit to concentrate the water resources of the country into a few large bulk supply undertakings, the smaller distributing undertakings would need to be amended over a period of time. It must be remembered that the distributing authorities would have the ultimate responsibility for purity and continuity of supply, and these undertakings should be large enough to insure adequate administration of that responsibility.

(e) Water Commission

Some water engineers have already expressed an opinion that a water commission consisting of all interests affected by the water resources of the country should be formed, somewhat on the basis of the Electricity Commission. This commission, in their view, should take over the inland water interests of the Ministry of Health and some other departments; should advise the Government on matters of national policy in relation to water resources; and control the compilation of records, etc. The formation of this commission would not conflict with proposals outlined previously or with the industry as now functioning, and might, if carefully constituted, be of real assistance both to the water industry and the nation as a whole and might be a useful preliminary step before embarking on any more drastic alterations, if such should be proved necessary. The commission would form a valuable liaison between water undertakings and the planning departments in the control of postwar developments and, if truly representative and well balanced, could go a long way to prevent powerful private and vested interests from obstructing unreasonably the best interests of the community.

Rural Water Supplies

The Committee on Land Utilization in Rural Areas under the chairmanship of Lord Justice Scott included in their report (para. 167) the following statement: "We consider the provision of a piped water supply an essential service in every village and on every farm, a desideratum in every dwelling."

The memorandum of evidence submitted to this committee by the British Water Works Association discussed this problem in some detail and also drew attention to the considerable progress made in the matter in 10 yr. preceding this war. In the conclusion to this memorandum it is suggested "that the problem of rural water supplies in general is, in fact, not a problem of engineering but one in terms of cost."

This latter statement is correct in that where sufficient money is available some sort of piped supply can usually be obtained, and that the large cost per capita of rural water schemes is the principal cause of failure to provide a piped supply. Nevertheless, in the author's opinion, it is not correct to assert that the problem of rural water supplies is not also an engineering problem, for the engineering difficulties of rural water supply schemes are peculiar and considerable. The same standard of responsibility for providing continuously a pure water supply is equally pertinent in rural schemes as in urban areas but the difficulties in realizing and maintaining the necessary standard in a rural area are considerable, owing to the limited funds and technical supervision available for the construction and maintenance of works.

It is considered, therefore, that the

engineering problems involved in the construction and maintenance of rural water supplies present special difficulties which merit careful consideration, particularly concerning the possibility of and need for the grouping of responsible authorities in relation to available supplies. In this latter respect the work of many water companies as well as large local authorities, who, by enterprise and foresight, have accepted responsibility for adjacent rural areas and thus have been able to afford a good piped water supply to small communities, should receive recognition and their experiences are worth studying with a view to reaching a solution of the problem throughout the country.

Unless it is possible for continuous efficient control to be maintained by qualified personnel over rural water supplies there are the same dangers of epidemics or other ill effects as are latent in larger undertakings and, although there is not the same chance for these dangers to take place on a large scale, they are none the less important. This efficient control can only be maintained if the areas of supply are large enough to support an efficient skilled staff, especially as larger areas are more easily administered in these days of rapid transport than was the case even 20 yr. ago. Consequently, while it is often possible to build a water works economically on a small scale it is not possible, except in unusual cases, to administer and control such small works satisfactorily, at any rate as completely independent units. It would be desirable to set out by agreement some standards of size for rural undertakings. For example, they could be limited to areas of supply not greater than 600 sq.mi. and populations of not less than 50,000. These conditions, which may not always be realized, would compel the inclusion of urban or semi-urban areas in the same district of supply, which is considered a desirable feature.

Distribution and Movement of Population

An opinion on the effects of postwar distribution of population on water supplies involves a considerable amount of surmise and it is mainly on this account that a distinction is necessary between Mr. Churchill's four postwar "reconstruction years" and the subsequent period of "planned development." To a certain extent these two phases will probably be interwoven, as it is to be hoped that one will follow logically from the other; but it is difficult to visualize a comprehensive scheme of planning being evolved, generally accepted and put into operation immediately after the end of the war. On the other hand, the housing problem will be acute and it is imperative that some remedies or palliatives be applied immediately conditions allow.

Consequently, the water industry may find itself faced with two postwar schemes during what is to water engineers a comparatively short space of time. The first, an urgent housing scheme designed primarily with a view to rapid completion, not all of it necessarily on the sites of the property it is replacing nor coinciding with any major planning scheme; the second postwar scheme, planned on more careful and desirable lines, may be evolved on a very different lay-out from a water works point of view and after a fairly short period may dislocate distribution systems and even change radically either way the total demands on the resources of some undertakings. Further complications would arise if the

otherwise attractive idea of regulating towns to reasonable sizes were encouraged. These views may be considered unduly pessimistic and planning may be able to avoid such complications, but avoidance can best be achieved by realization of the possibilities and by water engineers being called in during the early stages for advice in the matter.

The permanent distribution of the population will be largely determined by the distribution of industries; the war has witnessed a dispersal of factories into rural areas, a policy which, with proper safeguards, is likely to be encouraged. Such a policy cannot but have a useful strengthening effect on rural public services and, provided it is not unduly rushed and allowance is made for ample collaboration and necessary adjustments, it should help considerably to reduce the disparity in living conditions between urban and rural areas.

Available Water Supplies

From many points of view knowledge of the available water resources of the country is the basis of postwar planning, as it partially determines the suitability of particular areas for development. Water engineers have deplored for many years the paucity of information on the flows of this country's rivers and the resources of its underground storage. This matter was mentioned at length in a paper by Dr. Albert Parker recently published in the *Journal of the Institution of Civil Engineers,** in which reference was made to the work of the Inland Water Survey and the Geological Survey under the authority of the Ministry of Health and Secretary of State for Scotland in the former case and the Department of Scientific and Industrial Research in the latter.

Dr. Parker summarizes the present situation very clearly in the following words:

> The position, therefore, is that fairly comprehensive records of rainfall are available and are being collected, but that the data on the quantities of surface and underground waters are far from adequate, and very few records on the quality of the waters are available. It is to be hoped that when peaceful times return the work on underground waters by the Geological Survey and the records begun by the Inland Water Survey Committee can be widely and rapidly extended and that arrangements will be made systematically to collect records on the quality of the surface and underground supplies. Unless such surveys are undertaken rapidly and systematically, satisfactory planning of towns, industries, and urban and rural areas will not be possible.

There can be no dispute with the importance of this matter and, since water engineers are so intimately concerned with this subject, it is they who should encourage, assist and organize the collection of full information about this country's "available water." Apart from the new information which can be acquired if suitable facilities are made available, there is a mass of information hidden in the records of water undertakings and other similarly interested bodies which, given the safeguards necessary to make it public, would go a long way to make good the deficiencies in our knowledge.

Knowledge of the amount and quality of available water in the country is required without delay, as it is one of the foundations of future planning. A report on the distribution of available water supplies, based on information already collected and stored in hidden records, treated confidentially in detail

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* "Treatment of Water for Domestic and Industrial Requirements: Some Problems and Methods," by Alfred Parker, D.Sc., J. Inst. Civ. Engrs. (Br.) (Oct. '42).

if necessary, together with existing published records would provide an invaluable foundation for advice on the distribution of industry and population. Whether or not such a report is produced by the efforts of a committee of water engineers or under the guidance of a government department matters little, so long as the information is obtained, but a successful effort by water engineers to make available to the nation the information on water resources which they and their predecessors have accumulated, in a manner readily usable for planning purposes, would enable the water engineering profession to take its proper place in advising on these aspects of postwar problems, particularly as they are technical matters on which engineers alone are qualified to speak. Only in this way will uneconomic "panic" schemes and repetitions of previous errors be avoided after the war.

It is not sufficient merely to produce masses of figures relating to river flows, etc.; some interpretation must be placed on them to enable them to be used for purposes of planning. Sources of water suitable for public supplies should be segregated from those which are unsuitable and these selected sources should again be subdivided into various classifications like impounding, direct abstraction from rivers and underground supplies. Some relationships should then be established between the amounts of water available and the existing population; this may best be done on a county basis in order to facilitate the obtaining of population figures. If it were thus possible to find the quantity of water reliably available every day per head of population, some rough indication could be given of districts most capable from a water supply point of view of supporting new industries and population. In preparing such an analysis, much unnecessary work could be avoided by having due regard to the degree of accuracy of the methods employed; for example, although actual river gagings will provide reliable information, the discharge of ungaged rivers and underground sources will be obtained from estimates, as also will in many cases be the assessment of the quality of water. Subsequent relationships with population need only then be calculated to an equivalent degree of accuracy.

Such a survey would form a basis on which to advise on the location of industry and population as ascertained by available water, but actual schemes will, of course, need to be investigated in the usual way. Incidentally, in making the estimates of available water, allowances on a reasonable scale are necessary for the protection of the usual riparian interests and a very useful appendix to any report on available water resources could be provided in the form of a schedule of suggested amounts of compensation water, percentages of minimum river flows which may be abstracted and allowable reductions of ground water levels.

In calculating the lowest probable flows of rivers in connection with direct abstraction schemes it would not be sufficient to base the calculations on a rainfall comparison with another gaged river unless allowances were made for the very considerable variations in behavior of even adjacent rivers. Assessment of the dry weather flow on the basis of cusecs per 1000 acres can be very misleading, as the area of the catchment from considerations of size alone has little effect on the minimum flow in comparison with the topographical and geological characteristics, although such assessments

may be more correct in the cases of floods and average flows.

A survey of this nature would be a very considerable undertaking but not insuperable in comparison with some surveys produced by other organizations and it would form a valuable nucleus to which new information could be added as it becomes available and would in time enable estimates of water resources to become fairly exact calculations instead of matters for conflicting evidence and occasional disappointment.

Education and Research

Rapid technical advances in recent years have made great demands on the flexibility of technical education and some shortcomings have already received considerable attention by eminent authorities, so that further detailed reference here could not usefully add to what has already been written. It is merely necessary to remember that improved education is the basis for progress and demands continual attention. Perhaps it may be mentioned that the careful selection of suitable candidates for a civil engineering career is essential and should not be entirely based upon theoretical knowledge, but upon character and interests as well. The tragedy of a person who embarks and wastes time on a career in which he is not truly interested and to which he is unsuited from other considerations must be avoided if only to prevent waste of manpower in a country whose growth of population has become slow. This is particularly important in the civil engineering profession, which makes special demands on the physique, character, ability and interests of its students and the profession can only benefit by restricting entry to those candidates who are suitable in all respects. Psychological methods may be worth investigating as a method of examining intending students, articled pupils or assistants, in addition to the examination facilities already provided.

Technical research has been included under this heading with education, as such research can in most cases be best carried out by or in collaboration with the universities. Most modern inventions and improvements are the results of co-ordinated research by a number of investigators and, except in the case of extremely large concerns and the special government departments, this is not possible. Consequently, close collaboration between industry, profession and university offers the greatest opportunity for improving technical knowledge. So far as local problems are concerned this collaboration can, given the desire, be quite easily arranged between the parties concerned, but on problems of major importance it must be left to the various engineering institutions and special government departments to institute and make financial arrangements for the work to be carried out in a proper manner. These policies of organized research have been encouraged considerably in recent years, but a great deal more could be done if the cost of research could be more easily met and if the small parcels of information already available could be collected and used to a common purpose. The symposium produced by the Institution of Water Engineers after the 1933–34 drought was an excellent example of what can be accomplished in the way of collecting information—a method which could profitably be applied more often to subjects which are of sufficient importance to warrant the large amount of work involved. It is probably on work of

this nature that the younger engineers with their more recent scientific training might be encouraged to serve, at the same time giving them opportunities for experience of work in committee which would be useful both to them and the Institution if, later in life, they are called upon to give more important service to the profession.

The future status of water engineers in this country will depend more and more on the extent to which improvements can be made in engineering methods, particularly if stabilization of the population and demand for water should reduce the demands for new works.

International Co-operation

Of necessity much is heard nowadays of the value of international co-operation in sharing ideas as well as equipment for the furtherance of the common cause. All peace-loving peoples hope fervently that this co-operation will continue in the future in a manner calculated to promote better understanding and in order to raise the standard of living throughout the world. Apart from the obvious higher motives attached to international technical collaboration, the knowledge and experience accumulated by this country constitutes a valuable "invisible export" which should not be neglected.

It was most unfortunate that the outbreak of war caused the cancellation of the visit by members of the Institution of Civil Engineers to the United States for the British-American Engineering Congress, which was to have taken place in September 1939, but it is to be hoped that after the war further opportunities will be found for meeting and that the American engineers will also be able to honor this country with an official visit.

As a matter of fact, the inevitable speed-up of transport may make it possible in the near future for the Institution of Water Engineers to hold some of its summer meetings in other countries and for the reverse also to be true.

Apart, however, from contact between the technical organizations of various nations, personal contact by individuals is desirable and advantageous. This personal contact can be officially encouraged by arranging exchanges of junior staff between various undertakings in all parts of the world, particularly throughout the Empire, for suitable periods, as is already done in the teaching profession. This is the only way in which men can become acquainted intimately with their opposite numbers in other countries early enough in life to obtain full value from the experience and also to give full value in return.

Immediate Postwar Problems

As soon as the war is ended, if not before, water engineers are likely to be confronted by an acute intensification of problems arising from shortage of materials, suitable staff and housing and detailed consideration should be given to these matters now.

(a) *Shortage of Materials*

The early military successes of the Japanese lost to the United Nations 90 per cent of their natural rubber supplies and after stocks are exhausted the scarcity of this material may become even more acute. So far as the water supply industry is concerned the shortage will probably be felt most keenly at the immediate conclusion of the war, when water undertakings will be carrying out a good deal of new work and overdue maintenance. By this time synthetic rubber may be fairly generally available and its slightly dif-

ferent characteristics will have to be understood. For similar reasons, lead and tin may continue in short supply for some time and existing substitutes will have to be used. Most water engineers are now very well acquainted with their own particular scarcities and a good deal of attention has already been given to substitute materials. No doubt further new materials, at present wholly reserved for armament production, will become available on the cessation of hostilities and may prove very useful.

(b) Shortage of Staff

Some time ago civil engineering university students ceased to be reserved from military service and the result of this action, together with losses by casualties, will be most keenly felt for some years after the war. There is every indication that an even worse state of affairs than that which came about after the last war may arise in respect of qualified engineering assistance owing to the greater amount of work requiring to be carried out. On the other hand, there will no doubt be a large number of potential engineers whose training has been postponed or interrupted as a result of the war and the solution may be and should be to give these men every facility and encouragement to complete their qualifications, provided that the minimum depreciation is allowed in the standard of ability required. In any case considerable responsibilities will rest with senior engineers and technical bodies to maintain the standard of engineering training and performance during the transition period.

(c) Housing

This is a problem in which the general public takes a very great interest, and it can be anticipated that extraordinary demands will be made upon water works in connection with the extension of supplies. Unfortunately very little can be done at present to ease the blow when it should fall, except to become acquainted with the housing proposals if they exist or are available, and also to prepare the organization of main-laying departments for the large amount of work many of them may be called upon to carry out. In this connection the plea made previously for early collaboration between the water engineer and the housing authorities is renewed.

Other immediate duties at the end of the war will include the happy task of removing unsightly defense precautions, the overhaul of plant and equipment which may have been carrying exceptional loads during the war with a minimum of maintenance and repairs to property which it has not been possible to maintain satisfactorily. Claims for war damage and other expenditures subject to grant will have to be agreed upon, no doubt taking up a lot of the engineer's time in the process. These and many other things in addition to normal duties will constitute the new problems which will suddenly arise when the war is over, all at a time when important changes, involving careful study and interest in the methods of government, both local and central, may be contemplated.

Not all water engineers are engaged in water supply, and, with the revival of agriculture and the new appreciation of its value, land drainage engineers have already been called upon to carry out important works of improvement. If expressed intentions of the present are any guide to future actions, they will be called upon to carry out still more important work of construction

and maintenance in the future. Catchment board and land drainage engineers have much leeway to make up owing to the neglect of agriculture and associated matters in pre-war years, and as regards the prevention of pollution, they will receive very willing collaboration from all water engineers in any measure which will lead to more effective control.

Water engineers in this country have also acquired, as a result of the war, further interest and sympathy for their counterparts throughout the Empire, particularly those who have worked in areas overrun by the enemy, and great concern must be felt in the reconstruction and re-organization of such unfortunate undertakings when the areas they serve are liberated.

Conclusion

One of the good results which so paradoxically appear from the evil of war has been a realization by the general public of the essential value of a good water supply, and this realization must not be allowed to lapse; it should rather be cultivated so as to lead to an increased interest by consumers in the services which maintain their life and health. This interest, apart from its resulting benefit and the encouragement to water supply officials, is one aspect of the good citizenship which will be necessary in order to make a rapid recovery from the upheaval of war.

A healthy and lively general interest in public services does not, however, make life any easier for water engineers and, if such an interest should lead to a desire for radical alterations after the war, water undertakers and their officials will need to be fully alive to their obligations to advise on such alterations and be prepared to serve the best interests of the community even more assiduously than before.

This paper has been a brief attempt to outline some personal opinions and thoughts on the state of affairs with which the profession will be confronted at the end of the war. As the survey progressed it was accompanied by a growing sense of the vast range and implications of so important a subject, and it is realized that many topics, such as the ownership of land and control of catchment areas, have not been dealt with at all. An appreciation of the great changes already caused by the war and the still greater changes that the peace will inevitably bring will call for much careful consideration as well as hard work by all members of the profession in order that satisfactory solutions can be found to the new problems now arising from changes in the mood and ways of life of the nation, changes which cannot be avoided or ignored.

Other sections of the community are working hard to produce plans for the future, and the considerable efforts already made by water engineers in this direction must be continued and encouraged so that the specialized knowledge which they can bring to bear on postwar problems can be put to good use in collaboration with other bodies aspiring to the same ends.

Outline of Design Factors for Steel Water Pipelines

By Russell E. Barnard

STEEL pipe is a product of great adaptability. The standards embrace many sizes and wall thicknesses; there are hundreds of standard fittings and accessories. As a material, steel can be rolled, formed, welded, forged or cast. The shapes that steel may be made to take are infinite in number, which means that any common requirement can be met; but the proper selection of what to use in a given case, under given operating conditions, becomes a matter of judgment and engineering design. Manufacturers and users of steel pipe for water service have had much experience in this matter of application, and have contributed to the solution of common and special problems.

The aim of this paper is to gather and present general engineering data and references bearing on the more common problems met in the design of steel water lines.

Flow Capacity

The primary purpose of a water line is to deliver water. Size determination hinges on that point. Although variation in the ability of different pipes to deliver water should be considered, many times it is not considered and the same diameter of pipe is specified for all types of material. As far as steel pipe is concerned, the same diameter is almost always specified whether it be unlined or lined with coal-tar enamel or cement. This should not be done.

The coefficients for these different types of pipe and conditions of pipe interior are different. The capacity differs with them. It is known that a lined pipe of given diameter carries more water than an unlined pipe of the same diameter. Conversely, a lined pipe may be smaller and still carry the same quantity as the unlined pipe.

Flow capacity also varies with the age of the pipe. Many investigations of both new and old lines have provided valuable engineering data regarding new and old pipe and while it is known that the data are not completely accurate, they must be used until better data are available. These studies are continuing.

For steel pipe, two well known formulas are applicable—the Scobey formula and the Hazen-Williams formula.

The Scobey formula (1) was developed from flow tests made on steel pipe most of which was hot asphalt dipped. Since the asphalt did not in all cases prevent tuberculation, the flow capacity calculated using the Scobey formula, applies primarily to *unlined* pipe. In Table I, are given the values of the co-

A paper presented at the Cleveland Conference, June 17, 1943, by Russell E. Barnard, Advisory Engineer, Spiral Welded Pipe Dept., American Rolling Mill Company, Middletown, O.

efficient K which apply to unlined steel pipe that meets A.W.W.A. specifications and which is either "Dresser" coupled or field welded.

The Hazen-Williams formula is commonly used to determine flow capacity of *lined* steel pipe as well as pipe made of material other than steel. It is known that for pipe above 36-in. diameter the formula must be used with care. However, at present it is probably as good as any recognized formula and because many of the coefficients derived from flow tests have been related to it, the formula is most useful.

At least one coal-tar enamel lined steel pipeline has been checked for discharge both when first laid and again after eight years' service. These tests were made on 50,700 ft. of 30-in. pipe having centrifugally cast coal-tar enamel lining. The line was laid and tested in 1933 and again tested in 1940 (2). It contained 85 horizontal and 80 vertical bends. The bends were of segmental type on 6-ft. to 10-ft. radius having deflection up to 70 deg. These bends offered hydraulic resistance over and above that of straight pipe.

In the 1940 test the lowest value of Hazen-Williams C was 145.5 and the highest about 151. The corrected average was about 145 which was one point above the C value found in 1933.

Conclusion was that this pipe, which was lined in practical accordance with present A.W.W.A. coal-tar enamel specifications (3), had experienced no lowering of coefficient during eight years of service. If the head losses due to bends had been deducted as separate losses, the coefficient would have been higher.

Many other flow tests made as checks against calculated capacities of new coal-tar enamel lined pipes are in substantial agreement with the foregoing values.

When minor losses due to bends, valves, etc., are treated separately, a design value of $C = 150$ is indicated for steel pipe lined in accordance with A.W.W.A. steel pipe specifications.

Pipe Sizes

In sizes 28 in. and smaller, steel pipe has been fully standardized. The A.W.W.A. small steel pipe specifications (4), show these sizes. Larger sizes have been partially standardized. The War Production Board, co-operating with manufacturers and users, has issued a limitation order covering general piping. This order lists the sizes and wall thicknesses of steel pipe for general use during the period of the war. It is in the interest of economy that these sizes be used both during and after the war.

Wall Thickness Determination

Steel pipe wall thickness is determined by considering the following factors:

1. Internal pressure.
2. External pressure
   a. Uniform loading
   b. Trench loading.
3. Special physical loading
   a. Lined pipe in transit
   b. Pipe used as bridge.
4. Resistance to corrosion.
5. Code or regulation requirements.

Usually more than one of the foregoing engineering factors must be investigated and the final wall thickness selected will be determined by that which gives the greatest value.

It also happens that in some cases minimum wall thickness as technically determined, is less than the minimum fixed by code or regulation and in such

cases the factor 5 will actually govern the final selection.

Internal Pressure: Relative to water pressure and water-hammer used in computing the thickness of *cast-iron pipe,* the following is quoted as an "American Recommended Practice" (5). The data on pressures apply equally well to *steel pipe:*

"The static pressure will of course be known or assumed from conditions fixed by the pipeline design. The intensities of water-hammer vary greatly according to types of gate valves, check valves and altitude valves; types of pump and power; presence or absence of automatic relief valves with effective quick acting controls; arrangement of pipeline, i.e., whether single or part of a grillage system; and other factors which it

TABLE 1 of A21.1 Sec. 1–7

Allowances for Water-Hammer

Diam. of Pipe, In.	Water-Hammer, Lb. Per Sq. In.	Diam. of Pipe, In.	Water-Hammer, Lb. Per Sq. In.
4 to 10	120	24	85
12 to 14	110	30	80
16 to 18	100	36	75
20	90	42 to 60	70

would require too much space to enumerate. Experiments on water-hammer under the various usual conditions in which water pipe are used are few and Committee A21 has been unable from its inquiries to suggest improvements over the assumptions of water-hammer made by the late Dexter Brackett, which have therefore been used in computing the thickness tables. They are listed in the table (*above*). *Each designer of a pipeline should consider whether the conditions in his case may need a more liberal water-hammer allowance.*"

It will be noted, by referring to Sections A4–3.1 and 3.2 of A.W.W.A. Standard Specifications 7A.4 (4), that the working pressures for steel pipe are high when compared with operating pressures ordinarily prevailing in

TABLE 1

Values of K *in Scobey Formula*

Age of Pipe in Years	Aggressive Waters		Relatively Inactive Waters	
	Conservative Values of K	Percentage Flow Capacity	Suggested Values of K	Percentage Flow Capacity
1	0.320	100	0.320	100
5	0.345	97	0.336	98
10	0.372	93	0.354	96
15	0.401	90	0.372	93
20	0.432	86	0.391	91
25	0.466	83	0.411	88
30	0.502	80	0.432	86
35	0.541	77	0.454	83
40	0.583	74	0.477	82
45	0.628	71	0.502	80
50	0.677	68	0.528	78

water works systems. Consequently, this extra strength provides a reserve against water-hammer pressure and other forces.

In cases where higher than ordinary static pressures prevail in a water pipe, and tensile wall stress is accordingly high, it becomes necessary for the designer to investigate water-hammer. Useful data and methods to be employed in such investigations have been published. Some are long and technical in character (6, 7, 8, 9, 10). Others are short but helpful (11, 12), and some deal with means of relieving water-hammer (13, 14).

Working Metal Stress: Wall thickness of steel water lines to resist internal presure is ordinarily determined by using the Barlow formula plus an assigned constant for permissible under-thickness tolerance or corrosion allowance. There is a growing tendency to increase the former allowable working stresses for steel, and to base this working stress on the yield strength of the steel rather than its ultimate strength.

In the 1942 American Standard Code for Pressure Piping (15), for steel comparable to that specified in A.W.W.A. steel pipe specifications and operating at about 100°F. temperature, the allowable stress for fusion welded pipe shows a low of 7700 psi. in power piping systems; 14,400 psi. in gas and air systems within boundaries of cities and oil piping systems within refinery limits; and a high of 20,400 psi. for oil piping systems outside refinery limits.

As examples of the yield strength basis approach, the code working stress for 30-in. and larger steel pipe in gas and air piping systems within city limits is taken as 0.48 times the specified yield strength. Also, for gas and air piping systems outside city limits, the working pressure in the pipe may be taken as high as 80 per cent of the mill test pressure which in turn may be high enough to stress the pipe wall to 90 per cent of the stipulated minimum effective yield strength. Thus the working stress can be a maximum of 72 per cent of the yield strength or 21,600 psi. for 30,000 psi. yield strength steel.

A study of penstocks (16) shows that in the gross pipe wall section, under static head only, the stress in psi. in welded pipe varied from 7650 to 13,500 and for sixty-five installations averaged 10,300. Other investigations indicated that general practice in penstock design is to use working tensile stress of 16,000 psi. considering static pressure plus surge pressure.

The Underwriters' Laboratories, Inc., use stress of 12,000 psi. plus $\frac{1}{16}$-in. corrosion allowance in fixing minimum walls for supply lines outside cities and towns, and 7200 psi. and $\frac{1}{16}$-in. corrosion allowance in distribution systems. In the larger sizes the latter figure produces excessive wall thickness.

The A.W.W.A. Standard Specifications for Steel Pipe (4) tabulate working pressures for pipe under 30 in. based on working stresses of 10,000 psi., or 12,500 psi., depending on the steel in the pipe and the method of pipe manufacture.

Considering the high requirements of standard specifications and present good manufacturing practice, design stress for hoop tension as high as 16,000 psi. in steel water pipe is warranted.

When the pipe is fully protected against corrosion in accordance with A.W.W.A. coating specifications (3), the addition of a constant thickness for corrosion resistance appears unjustified.

External Loading: Wall thickness must be determined to resist external loading properly. This may take the form of outside pressure, either atmospheric or hydrostatic, both of which are uniform, radially acting collapse forces. Also the wall must resist trench or fill loading neither of which is a uniform, radially acting force.

The general theories of collapse resistance of steel pipe to uniform, radially acting forces have been carefully studied, and results tabulated. These studies apply especially to oil well casing sizes and thicknesses (17). Within the range of pipe sizes ordinarily used by water works engineers, the approximate collapsing pressure of pipe subjected to uniform, radially acting force is given in Table 2.

The behavior of steel pipe under earth load presents a different kind of problem. Engineering data for this condition are given in a paper scheduled for publication in the JOURNAL (18).

TABLE 2

Approximate Collapsing Pressure of Steel Pipe

Outside Diam.	Wall Thickness	Collapsing Pressure	Outside Diam.	Wall Thickness	Collapsing Pressure
in.	*in.*	*psi.*	*in.*	*in.*	*psi.*
6	0.172	1180	18	0.1875	60
	0.1875	1530		0.250	140
	0.250	3640		0.3125	260
8	0.172	500	20	0.1875	40
	0.1875	650		0.250	100
	0.250	1530		0.3125	190
10	0.1875	330	24	0.1875	25
	0.250	780		0.250	60
	0.3125	1530		0.375	190
12	0.1875	190	30	0.250	30
	0.250	450		0.375	100
	0.3125	890		0.500	230
14	0.1875	120	36	0.250	17
	0.250	290		0.375	60
	0.3125	560		0.500	140
16	0.1875	80			
	0.250	190			
	0.3125	370			

Special Physical Loading: This type of loading also has bearing on wall thickness. Two special cases may arise: (1) pipe shell, if lined, must be thick enough to prevent damage to lining while shipping and installing and (2) pipe may be required to act as self-supporting bridge.

The minimum wall thickness necessary to prevent lining damage depends upon the type of lining, the shipping and installing facilities, the atmospheric temperature and other factors. At present it is best in given cases to consult with the pipe manufacturers and the coating contractors on these points. Local conditions may, and probably will, govern decisions.

It is frequently difficult to determine accurately the wall thickness of pipe required to span a given distance between supports, or to find the maximum span corresponding to a given wall thickness. There are several factors to be considered in the solution of these problems. Excessive distortion or crushing must be avoided at supports. Intensity of beam stress must be kept within proper design limits. (It is suggested that combination stresses in steel pipe under these conditions may be considered proper if below 20,000 psi.)

When small diameter, heavy wall pipe is carried on supports, deflection is apt to be the critical factor. With larger pipe, especially that having the thinner walls, the critical condition exists at the support. With specially designed supports, beam stress, shear stress and hoop stress in the pipe barrel usually govern.

Engineering design methods and data pertaining to large diameter pipe have been published (6, 19). Past practice in the use of penstock piers has been recorded (16). Studies have been made on the collapsing pressure and support of thin-walled cylinders (20).

Rules have been formulated for the design of stiffening rings and their attachment to cylindrical vessels subjected to external pressure (21).

Resistance to Corrosion: Corrosion may occur on the inside of the pipe due to water action, or on the outside due to soil action. Experience shows that in neither case is the *strength* of the pipe seriously impaired. One series of hydrostatic tests of heavily corroded steel pipe showed an average bursting pressure of about 75 per cent that of new pipe (22).

Internal corrosion rarely ever penetrates the wall of any except the thinnest steel pipes. It should be avoided however because of reduction in flow capacity more than for any other reason. Internal corrosion is prevented

by water treatment or by lining the pipe.

Water carried may be corrosive either because of chemical reaction and deposit or because of bacterial content. Innumerable articles and treatises have been written on internal corrosion of pipe and what can be done about it. Local experience may be the best guide. Methods for gaging the chemical corrosiveness of water have been suggested (23) and checked (24).

Certain types of bacteria in water create corrosion in pipe interior, about which much has been written. Proper chlorination of water is one answer (25).

Exterior corrosion caused by soil action is usually more important than interior corrosion. Large scale investigations of the action of soil on ferrous metal have been made by the National Bureau of Standards, the American Petroleum Institute, the American Gas Association and others. Much information has been published. Interpretation of the official data from a designer's point of view has been made for water works engineers (26).

Cathodic protection of steel pipelines underground is an accomplished fact. The chances are that this method is in its infancy and will become more and more important and water works engineers should become much more familiar with it. The present status of the art has been summarized (27), the fundamental factors discussed (28).

Best present protective coating practice is followed when using coal-tar base enamel coatings and linings on steel pipe in accordance with requirements of A.W.W.A. coating specifications.

Code Regulations: There are several codes and good practice regulations governing the general and specific use of steel pipe, only one of which concerns water pipe (29). Besides containing a specification for steel water pipe and provisions for inspection, the standard tabulates minimum wall thicknesses for supply lines and for distribution systems.

Field Joints

The two types of field joints most commonly used with steel water pipe are: (a) the mechanical compression sleeve joint of the "Dresser coupling" type and, (b) field welding. Other types are flanges, "Victaulic" couplings and bell and spigot joints.

Dresser couplings are used on most lines 24 in. and smaller, especially those with coal-tar enamel lining. Very complete technical data are available (30).

Field welding may be used on smaller diameter unlined pipe as well as the larger sizes of lined pipe in which the lining can be applied or replaced at the joint after welding.

All welded lines must be designed and installed with due regard for contraction and expansion forces. Expansion joints should be provided at the junction with other lines and with valves, pumps and equipment, or structures liable to damage by displacement.

Data on field welding of pipelines, together with welder qualification tests and other welding information, have been published (31, 32). Specifications for field welding of water lines are now being prepared by the A.W.W.A. Steel Pipe Committee.

Flanges are mainly used for connecting pipe to flanged equipment such as valves, pumps, etc., rather than as regular field connections between pipe sections. An exception is plant piping

where flanges provide necessary resistance to end thrust in exposed piping systems.

Water works engineers specifying flanges should take note that the service rating of American Standard flanges is based on higher temperatures than prevail in water works service. Therefore the non-shock cold water service rating of the 150-lb. American Standard flanges is 230 psi. and of the 300-lb. flange is 500 psi.

Bell and spigot joints calked with cement have been used very successfully on steel pipe in warm climates (33). Spigot end adapters are supplied for connecting steel pipe to hub-end valves or to bells of cast-iron pipe.

Fittings

Steel pipe may be furnished with standard or special dimension fittings. They may be separate units or made integral with lengths of pipe.

Dimensions for American Standard flanged fittings 24 in. and smaller have been published (34). Dimensions for coupler end water pipe fittings as well as flanged fittings for sizes 6 in. to 36 in. also have been published (22).

High-pressure fittings and specials must be designed with proper strength. Rules for the design of nozzle openings (21) and for wyes, tees and laterals have been formulated (16), (35). Illustrative examples showing common practice have been recorded (36).

Expansion Joints

Unrestrained steel pipe expands or contracts about $\frac{3}{4}$ in. per 100 ft. of pipe for each 100°F. change in temperature. Expansion joints are therefore used on exposed lines but are usually unnecessary in well designed and properly installed buried lines, except for preventing thrust or pull loads which might otherwise develop undesirable stresses in valves, pump housings or other appurtenances. Expansion joints in pipe on bridges should be at points where the bridge structure itself contains a main expansion joint. On level lines the joint may be located midway between anchors to reduce pipe movement. On slopes the joint is usually best placed adjacent to and on the down-hill side of the anchor point. Positioning of expansion joints should be governed by site and profile requirements (16).

The stuffing box type expansion joint is most frequently used. Different manufacturers have different designs and their aid should be sought in given cases.

Anchorages

When it is required that steel pipe be anchored in concrete blocks, this is usually accomplished by welding rings or flanges to the pipe barrel. In general, anchors are placed only at angle points. A complete analysis of all stresses acting upon an anchor have been published (16).

Air Valves

Depending on size, air valves are attached to steel pipe by means of threaded connections or flanged tees. The largest size threaded connection used should be 6 in.

Air and vacuum valves should be placed: (a) just down stream from each across-the-line valve in a pipeline; (b) at all high points where the line will act as a true siphon when draining or in case of breakage or wash-out; (c) at abrupt changes in grade where the slope increases sharply; and (d) on long flat stretches at intervals of about 1000 ft.

Pressure air release valves should be placed at each summit where air entrained in the water may accumulate and form an air lock.

All air valves should be protected against damage and freezing by placing in non-air-tight housings.

References

1. SCOBEY, FRED C. The Flow of Water in Riveted Steel and Analogous Pipes. U.S. Dept. of Agric., Bul. No. 150 (1930).
2. CARPENTER, J. D. & ROADS, GEO. M., JR. Flow Tests on Thirty-Inch Steel Pipe, Lined with Bitumastic Enamel in 1932. J.N.E.W.W.A., **56**: 8 (1942).
3. A.W.W.A. Standard Specifications for Coal-Tar Protective Coatings for Steel Water Pipe of Sizes 30 Inches and Over—7A.5-1940; A.W.W.A. Standard Specifications for Coal-Tar Enamel Protective Coatings for Steel Water Pipe, up to but Not Including 30 Inches—7A.6-1940.
4. A.W.W.A. Standard Specifications for Steel Water Pipe of Sizes up to but Not Including 30 Inches—7A.4-1941-TR. Distributed by A.W.W.A.
5. Manual for the Computation of Strength and Thickness of Cast-Iron Pipe. ASA—A21.1-1939.
6. Penstock Analysis and Stiffener Design. *Part V*. Technical Investigations. U.S. Dept. of Interior, Bur. of Reclamation Bul. 5 (1940).
7. ALLIEVI, L. *Theory of Water-Hammer*. [Translated by E. E. HALMOS.] Distributed by Am. Soc. Mech. Engrs. (1925).
8. ANGUS, R. W. Water-Hammer Pressures in Compound and Branched Pipes. Proc. A.S.C.E., **104**: 340 (1939).
9. DAWSON, F. M. & KALINSKE, A. A. Methods of Calculating Water-Hammer Pressures. Jour. A.W.W.A., **31**: 1835 (1939).
10. GOIT, LAURANCE E. Water-Hammer Studies on Long Pipe Lines. Jour. A.W.W.A., **31**: 1893 (1939).
11. SUTHERLAND, ROBERT A. Approximate Water-Hammer Formulas. Civil Eng., **12**: 334 (1942).
12. MACPHAIL, J. B. Comments on Approximate Water-Hammer Formula. Civil Eng., **12**: 397 (1942).
13. BOERENDANS, W. L. Pressure Air Chambers in Centrifugal Pumping. Jour. A.W.W.A., **31**: 1865 (1939).
14. BENNETT, RICHARD. Water-Hammer Correctives. W.W. & Sew., **88**: 196 (1941).
15. *Code for Pressure Piping*—American Standard, 1942. Distributed by Am. Soc. Mech. Engr.
16. *Penstocks*. Edison Electric Institute Publication No. D15 (Dec. 1936).
17. WESCOTT, BLAINE B., DUNLOP, C. A. & KEMLER, E. N. "Setting Depths for Casing," in *Drilling and Production Practice*. Am. Petroleum Inst., (1940).
18. BARNARD, RUSSELL E. Behavior of Flexible Steel Pipe Under Embankments and in Trenches. (*In preparation.*)
19. SCHORER, HERMAN. Design of Large Pipe Lines. Proc. A.S.C.E., **98**: 101 (1933).
20. STURM, ROLLAND G. A Study of the Collapsing Pressure of Thin-Walled Cylinders. Univ. of Ill. Bul., Vol. 39 (Nov. 11, 1941) No. 12.
21. Rules for Construction of Unfired Pressure Vessels, *Section VIII* A.S.M.E. Boiler Construction Code (1940 Edition). Am. Soc. Mech. Engr.
22. Report on Steel Pipe Lines for Underground Water Service. Special Investigation 888. Underwriters' Laboratories, Inc. (July, 1936).
23. LANGELIER, W. F. The Analytical Control of Anti-Corrosion Water Treatment. Jour. A.W.W.A., **28**: 1500 (1936).
24. DEMARTINI, F. E. Corrosion and the Langelier Calcium Carbonate Saturation Index. Jour. A.W.W.A., **30**: 85 (1938).
25. THOMAS, ARBA H. Role of Bacteria in Corrosion. W.W. & Sew., **89**: 9 (1942).
26. BARNARD, RUSSELL E. A Method of Determining Wall Thickness of Steel Pipe for Underground Service. Jour. A.W.W.A., **29**: 791 (1937).

27. LOGAN, KIRK H. The Status of Cathodic Protection of Pipe Lines in 1941. Gas, **18**: 50 (May, 1942).

28. EWING, SCOTT. *Soil Corrosion and Pipe Line Protection.* Am. Gas Assn. (1938).

29. Standard for Steel Pipelines of Underground Water Service, Sp. I. 888–38, Underwriters' Laboratories, Inc.

30. KILLAM, ELSON T. Mechanical Joints for Water Lines. Jour. A.W.W.A., **35**: 1457 (1943).

31. *Welding Handbook.* American Welding Society, 1942.

32. PRICE, H. ARTHUR & GARRETT, G. H. Field Welding of Steel Water Pipe. Jour. A.W.W.A., **35**: 1295 (1943).

33. HURLBUT, W. W. Steel Trunk Lines With Bell and Spigot Joints. Jour. A.W.W.A., **22**: 1178 (1930).

34. American Standards Association Steel Pipe Flanges and Flanged Fittings. ASA—B16e–1939. Distributed by Am. Soc. Mech. Engr.

35. GINDER, CHESTER J. & COBB, EDWIN B. Design of Fabricated Plate Steel Tees, Laterals and Wyes of Large Diameters for the Pressure Aqueduct of the Boston Metropolitan District Water Supply Commission. Jour. of Boston Soc. of Civil Eng., **28**: 94, No. 2 (April, 1941).

36. BARNARD, RUSSELL E. Fittings and Specials for Steel Pipe. Jour. A.W.W.A., **33**: 1751 (1941).

Important Priority Rulings

THE War Production Board announced on January 6, 1944, that extensions of public sewerage systems costing less than $5,000 may now be made to building projects authorized under Conservation Order L–41 with a minimum of preliminary paper work.

Amendment of Preference Rating Order P–141 renders it similar to orders of the Office of War Utilities, which provide uniform procedures for expeditious installment of utilities extensions.

Under the old terms of P–141, sewerage systems might be connected with approved projects only after specific approval by WPB. Now all that is required is a certification by the system operator, delivered to the builder, for attachment to the latter's application for approval to begin construction.

The amended order also assigns a preference rating of AA–3 and an abbreviated CMP allotment symbol to orders for materials required by an operator to install extensions.

The War Production Board's Policies as Related to West Coast Water Utilities

By Arthur E. Gorman

EARLY in 1943 I had the pleasure of visiting California and contacting water utility operators in regard to their wartime problems and the related responsibilities of the Office of War Utilities. I am indeed happy and grateful for your kind invitation to return to meet with members of the California Section of the American Water Works Association to discuss further our mutual problems and relationships in maintaining water supply and service for war industries, Army and Navy establishments and for essential civilian needs. The impact of this war on the West Coast has been heavy, and there are positive indications that it will increase in intensity. This is reason why all of us who are concerned with water service should have a clear understanding of our responsibilities to the Nation and to our consumers. It is my hope that as a result of this meeting we can so coordinate our programs and policies that "come what *come* may" the water industry will be fully prepared to discharge its obligations.

A paper presented on October 28, 1943, at the California Section Meeting, Los Angeles, Calif., by Arthur E. Gorman, Director, Water Division, Office of War Utilities, War Production Board, Washington, D.C.

I should like to convey to you, the representatives of the water industry on the Pacific Coast, the warm greetings and sincere thanks of my chief, J. A. Krug, Director of the OWU, for the splendid manner in which you all have co-operated with the War Production Board and with one another in maintaining water service under most trying circumstances. To this I should like to add my personal feeling of indebtedness and that of the employees of the Water Division for the most friendly, courteous, and I might add, patient manner in which you have assisted us in our efforts to help you maintain service, using a minimum of those critical materials which are so important to the war program that they must of necessity be restricted in use. The OWU, and particularly the Water Division, has received the fullest co-operation of the A.W.W.A. in regard to water utilities' programs and policies.

California is a long way from Washington; and in many respects your problems vary markedly from those of water utilities in the rest of the Nation. But if each of you could spend as little as a few hours with us in Washington, I am sure you would be convinced that California utility situa-

tions are very much to the front in our daily deliberations. The importance which the Water Division attaches to West Coast water supply problems and the very special nature of your operating conditions are evidenced by the fact that the *only* decentralization of functional activities of the Division that has been made is the appointment, with headquarters in San Francisco, of Major Gerald Arnold—one of your members and a well-known water works engineer—to take charge of the Division's interests in Region No. 6 which includes the following eleven states: Washington, Oregon, Idaho, Montana, Wyoming, California, Nevada, Utah, Colorado, Arizona and New Mexico. The OWU is indebted to the U.S. Public Health Service for the loan of Major Arnold for this important assignment, and I am sure it is one which has pleased all of you.

The record of the West Coast water utilities in meeting their wartime responsibilities is an excellent one. Few areas have been put under a comparable strain as a result of the war program. On the basis of present conditions and the future outlook, it might well be said that from the standpoint of water supply and service, the utility systems of the West Coast now rate at the top in our consideration of materials need.

Some idea of the effect of the war program on the West Coast utilities may be obtained from the following comparison of population served by your large systems in 1940 and 1943 based on recent studies.

Among the smaller cities which have had extraordinary increases in population to be served are those shown in Table 2.

As the war progressed, there were many changes in the availability of materials, and the WPB has endeavored to adjust its policies with reference to their release accordingly. The materials situation is closely integrated with the overall war production and requirements program, as well as with the manpower and transportation situations.

Shortly after Pearl Harbor, there was much anxiety on the part of all utilities in regard to enemy action either by direct attack or through sabotage. West Coast utilities were especially concerned and with real reason. Water utility inventories were increased and there was much commendable and timely activity in developing mutual aid programs to assure an adequate supply of materials. The fortunes of this war have developed favorably for the Allies at an accelerated rate, and today, some of our earlier problems have been dissolved. Others,

TABLE 1

City or Utility	Population Served		Percent Increase
	1940	1943	
San Diego, Calif.	203,000	400,000	97
Portland, Ore.	305,000	504,000	66
Seattle, Wash.	368,000	590,000	60
Tacoma, Wash.	109,000	164,000	50
East Bay Utility, Calif.	519,000	775,000	50
Los Angeles, Calif.	1,504,000	1,740,000	15
San Francisco, Calif.	712,500	810,500	14

TABLE 2

City or Utility	Population Served		Percent Increase
	1940	1943	
Richmond, Calif.	16,000	106,000	600
Benicia, Calif.	2,400	12,000	500
Vallejo, Calif.	20,000	95,000	475
Bremerton, Wash.	15,000	60,000	400
Burbank, Calif.	34,000	54,000	59

such as manpower and transportation, however, have crystallized to the point of serious concern—especially here on the West Coast. The risk of damage by enemy action is generally recognized as considerably reduced.

Fortunately for the water utility, the acute shortage of cast-iron pipe, which a year ago was critical, has been lessened. Facilities for inter-change of materials and equipment in excess inventory have been developed and are operating successfully in conserving critical materials by reducing the necessity of new production. The changes in conditions affecting the water industry are typical of the changing tempo of our national life during this war. It is inevitable that they will continue, and we should prepare ourselves to meet them.

Early in 1943 the intensive war construction program—with certain notable exceptions—reached its final stages. Our war program was passing through a readjustment stage—one between the end of the construction period and the getting underway of the phenomenal production program. As a result, in some areas the impression gained credence that such critical materials as steel and copper were no longer tight; and that the WPB should relax priority restrictions on projects materials and equipment for civilian construction on a wide front. Nothing could have been further from the facts. There is no indication that steel and copper will be available for projects other than essential for many months. In fact, as the war potential has increased, the demand for these basic metals in war production has greatly exceeded output and fabricating capacity. We are reaching the period of maximum production which will continue until the war ends, being subject to such fluctuations in demand as military necessities dictate.

I should like to review some of the more important developments during the past year as related to the WPB and the water utility and indicate some of the trends toward future policies as they may affect our mutual interests.

From the standpoint of utility operations, perhaps the most significant development of the past year was the organization in February, 1943, of the OWU, with J. A. Krug, Director. Mr. Krug, before being promoted to the position of Program Vice-Chairman—which he still holds in addition to that of Director of the OWU—previously had been Chief of the Power Branch. Within the OWU, five major divisions were created. These were Power, Natural Gas, Artificial Gas, Water and Communications.

The prime responsibility of the OWU is to see to it that utilities are provided with the necessary materials

and equipment to maintain adequate service to meet all essential war production, military and civilian requirements. In turn, each of the Divisions in the OWU must discharge this responsibility to the respective utility it represents. That is why the Water Division is so vitally interested in your problems.

The OWU was made one of the seventeen claimant agencies of the WPB with the right to submit its own requirements program for allotments of materials under the Controlled Materials Plan, and to issue, without further review, authorizations for utility constructions and the allotment of materials. These important advantages made it possible to effect important administrative changes which have resulted in much more prompt and direct actions on project applications than had heretofore been possible.

The Water Division is charged with the responsibility for mobilizing water supply for war industries, military and naval establishments and essential civilian uses; and for recommending necessary measures to secure adequate water supply for these purposes. The Division is now organized into two major sections. (*See* December JOURNAL, p. 1506). These are the Water Supply and Materials Distribution. The technical staff has been increasing and now (October 1943) consists of 31 experienced water works engineers. Each is interested in helping you to maintain water utility standards and service.

The Water Supply Section has the responsibility of determining the water utilities' facilities and requirements necessary to maintain adequate water supply and service and of assuring that all WPB aids and services are extended in maintaining these services.

The Materials Distribution Section reviews applications from the standpoint of availability of materials and equipment, and compliance with limitation orders. It also issues the priority and makes the allocation of controlled materials. All water project applications from utilities should be filed on WPB Form 2774. Complete instructions in regard to preparing this form and to supporting the application by supplemental technical information were mailed to all utilities within the last two months. Here I should like to point out that altogether too many utilities are still using obsolete PD-1A and PD-200 forms in applying for priority assistance on water projects. Of course, if you submit them to us in error, we shall process the applications and not delay you by returning them, provided the supporting data are adequate. But those forms antedated the CMP program and do not provide for allocations of controlled materials. Therefore you will help yourselves, as well as us, if you will use the WPB-2774 application form for all water utility projects.

The designation of the OWU as a claimant agency in the WPB under the CMP is prime recognition of the importance of utilities to war production and for essential military and civilian needs. Under this plan which went into full effect July 1, 1943, this Office now receives, in quarterly allotments, a definite share of the available steel, copper and aluminum produced in this nation and is held strictly responsible for its allocation of these materials to the nation's utilities. CMP has done much to correct the difficulties previously experienced in getting materials under the old priorities system. Under this plan the recipient of an allotment of controlled

materials for any quarter is assured of delivery during that quarter. Allotments are made to manufacturers as well as to applicants for construction projects. Under the old priority system, a holder of a low priority was never sure of delivery dates because of inability to forecast how many higher priorities might be issued after receipt of his. These uncertainties worked hardships on both the applicant and materials producer.

Uniform Policies

While the general policies of the OWU are uniform for all utilities and each system may serve substantially the same consumers in some aspects, the relationships of the services rendered by these utilities to the war production program may vary widely, and their respective material and equipment requirements may differ considerably. For example, power utilities require large amounts of copper and little cast iron while water utilities use relatively small amounts of copper and large amounts of cast iron.

The requirements of utilities for materials and equipment fall in two major categories. First, those for maintenance, repair and operation, and second, those for extensions and betterments. The policies of the OWU in regard to priority ratings for materials and equipment for those requirements are consistent and definite. Even though war demands for materials are heavy, utilities will be supported to the fullest extent in maintaining essential plant. There is no materials economy in deferring necessary plant maintenance or repairs; in fact, such deferment may result in need of early replacements at a critical period during the war which would be directly in competition with war production. Shortsightedness along these lines should be avoided.

To assist utilities in maintaining plant with a minimum of reference to the WPB for priority assistance, a special order known as U–1 Order was promulgated on February 24, 1943. It is the successor to P–46 Order of the former Power Branch. It was broadened and liberalized in subsequent amendments. Under this order as amended September 22, 1943, utilities are given the right to extend an AA–1 priority and automatic allocation of controlled materials for maintenance, repair and operation except for material used for extending lines to consumers. For this material an AA–3 priority authorization has been granted.

This order is a very important one and should be understood by all in responsible charge of materials, equipment and supplies for utilities. Because the order controls materials for maintenance, repair and operation for three utilities—power, gas and water—responsibility for its administration within the OWU is centralized in an administrator, who clears with division directors. There have been discussions of the wisdom of separate U–1 orders for each utility to be administered within the respective Division, but this plan has administrative complications as well as advantages and the overall order is still in favor.

Maintenance Provisions

There is clear evidence that many water utilities are not taking advantage of the provisions of U–1 Order to maintain plant. Altogether too many water utility operators are submitting applications to Washington for work already permitted under the U–1 Order. The U–1–f amendment makes it unnecessary to obtain permission for

extensions to certain consumer premises where the net cost of material is less than $1,500. For water extensions to the specified types of consumers engaged in war work, up to 250 lb. of steel pipe or 2000 lb. of cast-iron pipe or 1000 lb. of lead or lead alloy pipe, or one of three named combinations may be used. The 100-lb. pressure limitation in the use of steel service pipe no longer exists. Under the amendment any kind of pipe except copper may be used for services. These changes make it possible to maintain sound minimum practice in installing water pipe of adequate size so that service for fire protection may not be hampered. Earlier in the period of the war when cast-iron pipe was tighter, it was necessary to place very close limitations on pipe sizes for such connections.

Automatic Priorities

Order U–1–h (published in December 1943 JOURNAL) permits extensions of utility service to certain industrial, commercial or other specially designated types of consumer premises of war significance up to $5000 but over $1500 for underground construction and up to $5000 but over $500 for other construction. In general, this amendment affects projects which now require PD–545 applications. It grants an automatic AA–3 priority and a CMP allotment number, U–9, and will lessen to a great extent the number of PD–545 applications which must be filed with regional and district offices of the WPB.

The policies at the OWU are tending definitely toward elimination of unnecessary paper work. The record of utilities in the conservative use of critical material is good. If this record is maintained, other relaxations may be looked for as the material, manpower and transportation situations improve.

Revision of Limitation on Inventories

During the last year several changes in limitations on water inventories were made. The reduction to 60 per cent of the 1940 base which went into effect October 10, 1942, apparently hurt none of the water utilities. But the further reduction to the basis of a current year's inventory included in the original U–1 Order resulted in strong objections by water utility operators. Therefore, the Order was amended on May 31, 1943, to revert to the old P–46 base. Again, with few exceptions, the utilities seem satisfied. It should be remembered that the order provides for increases in base on pumping plant and source of supply materials and equipment, proportionate to increases in production; and of course, in exceptional cases adjustments in base can be made to establish equity. Because of the special problems of West Coast utilities and their distance from manufacturing centers, utilities in this area that find that present inventory restrictions are too severe for safe operation may apply for special permission to exceed the limitations of the U–1 Order.

Recently, a considerable number of water utility operators have recorded their disapproval of the limitations in the use of copper under Order M–9–c–4, administered by the Copper Division; also, disapproval of the plan of the Copper Recovery Branch to redistribute and impound for scrap the copper reserve pipe held in excess inventory.

Under CMP Regulation Direction 30 (issued on September 21) no K, L or M copper water tubing could be produced until the brass mill has re-

ceived specific orders from the WPB in writing. (This Direction was suspended on November 25, 1943.) This Direction was intended to assure the disposal of copper water tubing in utilities excess stocks in its present form by direct negotiations between the holders and the potential buyers. The Water Division has just completed a study of the copper situation as related to stocks and hence by water utilities and the economics of its use as related to cost, manpower and good operation and we are hopeful that, as the copper situation improves, certain relaxations of prime importance to the industry will be made.

Special Exemptions

In presenting the case of several water utilities for special exemptions under this order, we have always found the Copper Division representatives sympathetic to your problems. But to date, in the light of the existing tight situation with regard to copper, that Division has been firm in its opinion that copper tubing in excess inventory was so urgently needed in the interest of the war effort that relaxations in the Order, other than those for repairs and for goosenecks, should not be made. While the Water Division has no jurisdiction over this copper limitation order, it is always ready and willing to co-operate with any water utility, where, because of special conditions involving safety and public health, it feels that special exemptions from the order are warranted.

In a few instances water utilities have found that the limitation in the use of copper sulfate to 1500 lb. per quarter worked a hardship in connection with algae control. The importance of this chemical for use by water utilities especially in areas where prolific growths occur in reservoirs is recognized by the Chemicals Division of WPB but the storage of large stocks of this chemical must be discouraged. That Division gives assurance that where the present limitations are too severe, relaxations will be made on recommendation of the Water Division. It is suggested that where special conditions exist, water utilities operators concerned make known their special needs for this chemical in a letter to the Water Division. Such requests will be given prompt consideration.

In regard to new construction and major extensions of existing properties, the strict policy of limiting materials for this work to projects essential to war production and military and civilian needs cannot be relaxed so long as the material, manpower and transportation situations continue to be tight. We must, therefore, continue to request water utilities to defer all possible major extensions and betterments. I am sure utility operators will understand and accept these limitations which may mean that for the duration we shall not be able to meet long established and normally excellent standards which call for considerable duplication of equipment and liberal standby service.

War Hazards Considered

As to special construction and equipment for protection against potential war hazards, the importance of maintaining reasonable fire protection facilities is obvious and is being supported by priority assistance. In the past, in connection with new housing there were instances where, because of the tight material situation, water service installations made were not wholly adequate for proper fire protection.

Survey Under Way

The Water Division is now engaged in several activities of special interest to all water utilities. During August and September, 1943, in co-operation with the U.S. Public Health Service, engineers of the Division have been contacting water utility operators in order to obtain information concerning current facilities and material requirements for maintenance and plant extensions. The prime objective of this survey was to obtain specific data to support the Division's request for quarterly allocations of controlled materials during 1944. It is planned to continue these surveys until sufficient basic data have been obtained on facilities and requirements in all cities where war requirements are important. This will also provide a wartime pattern on the basis of which material and equipment requirements for the entire water industry may be forecast with reasonable accuracy. The Division has enjoyed the fullest co-operation from water utility operators in connection with these surveys.

Starting September 15, the WPB launched a nation-wide conservation program with the coal, petroleum and transportation industries participating. Task Committees of the various industries co-operating in the campaign met late in July and outlined practical working programs for their industries. The report for water utilities was mailed to all water utilities in the nation (see September JOURNAL, p. 1249). The Wartime Activities Committee of the A.W.W.A. prepared a conservation program booklet which was distributed to water utilities serving a population of 10,000 or more, as a guide in organizing and carrying out the conservation campaign with their consumers through available local channels. We do not want to lower American standards of living by unnecessary restrictions on legitimate uses of water, but we do want to "use water usefully."

Seasonal Campaigns

Seasonal water conservation campaigns will be directed toward the reduction of peak load demands. We are hopeful that this reduction may reach as high as 15 per cent. If it does, it should permit the deferment of a very considerable amount of normal plant expansion projects calling for critical materials and equipment urgently needed in maintaining war production. We are well aware of the special need of water for irrigation purposes in California and the Southwest and the profound influence of rainfall on these regions' water requirements. The Victory Garden program has brought out a very important wartime use of water and deserved support. There is, however, much need for intelligent guidance on the part of water utility operators of consumers in the most effective way of using water to produce results without waste and unnecessary peak hour demands on their systems.

Co-ordinated Campaigns

I am sure that this conservation campaign will be given the fullest support by all West Coast water utilities. For maximum effectiveness we shall coordinate our water conservation campaign with those of the power, gas and communications utilities. Each utility operator should acquaint himself with the conservation program being developed by other utilities in his city or town.

Since the war began in the fall of 1939, with some local area exceptions, rainfall throughout the nation has

been above normal. We all hope that this fortunate state of affairs continues. But based on the historical record, the probability of continuance of abnormal rainfall is not good. Rather drought conditions are to be expected. This nation's war effort would be seriously affected if we were to experience a nation-wide or even regional droughts such as those of 1930 or 1936, which we all remember, when 63 and 64 per cent, respectively, of the area of the nation was seriously affected.

National Water Supply

California water utility operators need no special warnings from the Water Division concerning the seriousness of this potentiality. Should droughts of the intensity of those of 1897–1904 start in 1944 over the water sheds serving San Diego, for example, remedial relief measures would involve a very great expenditure of critical materials and manpower.

The U.S. Geological Survey has advised the Water Division that the water supply situation in general is "good to excellent" in California and that the immediate outlook in Oregon and Washington is most favorable. Control reservoirs are well filled and substantially above normal. During the winter of 1942 and the spring of 1943, conditions were exceptionally favorable for recharge of ground water sources. In southern California, however, as in other areas, there are still many overdeveloped local areas. Water levels are reported to be low in the Long Beach area.

Without adequate water supply, our war industries could not function as they must if we are to win this war with a minimum loss of life. Even periodic short-term interruptions of water service could seriously interfere with important war production, for our schedules of production are closely integrated. A delay in production of parts due to operating interferences in one area may affect the assembly of important war equipment elsewhere. Water shortage to housing areas would have a serious effect on labor turnover; water for irrigation is essential to the nation's food program; fire risks are much greater in relation to war production than most normal industrial operation. Finally, and of profound importance, is the basic fact that there is no substitute for water as there is for the service of other utilities.

For those reasons it is essential that all water utility operators appraise their system in regard to its basic points of vulnerability in case of prolonged drought; and be prepared with an emergency plan of action to meet essential war loads in case of drought. In case of a wide-spread drought, the OWU would be required to seek special allocations of materials and equipment to meet the contingencies of a prolonged drought.

There are areas in Louisiana, Mississippi and east Texas which experienced serious drought conditions during the summer of 1943. According to a recent water resources review by the U.S. Geological Survey, during the year ending September 30, 1943, areas of deficient water supplies, not including areas of heavy pumping for war industries, were confined principally to northern Maine, southern Florida, parts of the south central states, and the southern inter-mountain area, including Arizona, New Mexico, and southern parts of Nevada, Utah and Colorado. Numerous small water companies have used J. A. Krug's Administrative Letter (of July 28,

1943) to all utilities to bring to the attention of their consumers and the local press the need of co-operation in the conservation of water for war purposes. Any utility which desires to use this letter may do so if they will first communicate with the Water Division for clearance.

Several large water projects in the Mountain and Pacific Coast areas, each of which, if constructed, would require large tonnages of steel, have been deferred since the war started because favorable rainfall conditions have permitted existing sources to produce an adequate supply. Should rain and snowfall on these watersheds be subnormal during the winter of 1943–1944, the necessary materials must be released for water supply construction, but this action will lessen war supplies by that much. Without wanting to be an alarmist in this situation, it does appear prudent for all to consider the possibilities of drought emergencies and to prepare a plan of action to meet them if they should develop. The OWU will appreciate your co-operation in this important program of preparedness.

It is my firm opinion that the water industry throughout the nation and particularly on the West Coast, can be proud of the way it has maintained water supply and service to supply the greatest war effort this or any nation has put forth. But there is no room for complacency, because with a long war the strain on the water utilities will be a heavy one. We must continue to be alert and resourceful. To summarize:

1. The OWU is organized to serve you. Its Water Division is anxious to know your wartime problems and to help in any way possible in meeting war production and essential military and civilian needs.

2. All projects which can be deferred should be, because the materials, manpower and transportation situations are serious. The cast iron situation has improved, but steel, copper and aluminum are in great demand for war production and will continue to be tight.

3. Water utilities should maintain their plants in first-class condition. The OWU through its U–1 Order has given utilities ample authority to obtain materials necessary to maintain plant. There is evidence that water utilities are not taking full advantage of the opportunities this order affords. Too many project priority applications are still being referred to Washington. Every water utility operating executive should be thoroughly familiar with this order and its recent amendments, which reduces substantially the necessity of filing applications for minor constructions and consumer service connections.

4. The nation-wide conservation program being promoted by the WPB deserves the fullest support of all water utilities and should be integrated locally with the conservation program of related utilities.

5. The potential hazard to war production, should water utilities be faced with operations during a prolonged drought, is a serious one. Every water utility should appraise its plant to determine points of vulnerability in case of drought and plan what special priority actions should be taken to obtain necessary materials and equipment.

WAR PRODUCTION BOARD

WASHINGTON, D. C.

DEC 29 1943

IN REPLY REFER TO:

Mr. Harry E. Jordan
Secretary
American Water Works Association
500 Fifth Avenue
New York 18, New York

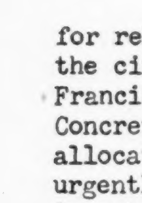
Dear Mr. Jordan:

Mr. Gorman has informed me that you have scheduled for publication in the January issue of the Journal of the American Water Works Association four papers describing methods used by California Water Works in rehabilitating used steel pipe in order that steel plate might be conserved for essential war purposes.

By their timely cooperation in developing plans for rehabilitating used steel pipe, the officials of the cities of Pasadena, San Diego, Richmond, and San Francisco, the Federal Works Agency, and the American Concrete Pipe Company not only made unnecessary the allocation of several thousand tons of plate steel urgently needed for war purposes, but also have rendered important service to water consumers in areas where adequate water supply for war production is most essential.

Publication of these articles at this time is a distinct service to water utilities as well as a timely aid to the War Production Board's steel conservation program.

It is another demonstration of the fine cooperation which the Office of War Utilities has received from you and members of the American Water Works Association; and I am deeply appreciative of it.



Sincerely yours,

J. A. Krug

J. A. Krug
Director
Office of War Utilities

The Removal, Reconditioning and Installation of 36-Inch Steel Pipe by the Metropolitan Water District of Southern California

By Robert B. Diemer

THE War Production Board in August 1942 rejected an application of the Metropolitan Water District of Southern California for 3500 tons of steel plate for use in the construction of a 12½-mi. pipeline extension to its Orange County feeder from Santa Ana to Corona del Mar for delivery of water to the recently annexed area known as the Coastal Municipal Water District lying along the coast including the city of Laguna Beach. It was necessary for the Metropolitan Water District to make every effort to build a pipeline as soon as possible to supply this area, as the salt water intrusion threatened to render its supply unfit for domestic use. In October 1942, the WPB approved the District's application covering the salvaging of an existing pipeline and the use of approximately $6500 of critical materials for the construction of a 12½-mi. pipeline.

Pasadena, one of the District member cities, had 11 mi. of 36-in. steel pipeline in the ground extending from Morris Reservoir in San Gabriel Canyon to Pasadena. This pipeline, of ¼-in. and $\frac{5}{16}$-in. welded steel plates, was built in 1934. It had not been in use since 1941 when the Metropolitan Water District took over control of Morris Reservoir and was ready to serve Pasadena from its distribution system which passed through the city. The District arranged for the purchase from Pasadena of the 36-in. steel pipeline in place after it was determined that the pipe, with proper conditioning, could be adapted for use in the Orange County feeder extension.

The soils along the location where the pipe was to be installed were mostly highly corrosive, making it necessary that the pipe be adequately protected with an exterior coating. The pipeline, when installed by Pasadena, was given an asphaltic coating interior and exterior with minimum thickness of $\frac{1}{16}$ in. Although the old coatings were in fair condition in some places, it was decided that no attempt would be made in the removal of the pipe to save these coatings. The specifications provided for the removal of the old coatings and the application of coal-tar enamel coating $\frac{3}{32}$ in. thick on the interior and ⅛ in. thick on the exterior, with a ¾-in. armor coat of gunite over the exterior coating of enamel.

A paper presented on October 28, 1943, at the California Section Meeting, Los Angeles, Calif., by Robert B. Diemer, Chief Operation and Maintenance Engr., Metropolitan Water District of Southern California, Los Angeles, Calif.

FIG. 1. Dragline Excavation in San Gabriel Canyon and Removal of Pipeline

FIG. 2. Excavation With Trencher. Removal of Pipe in Monrovia

Bids were received on November 24, 1942, covering the removal, reconditioning and installation of 11 mi. of this steel line together with $1\frac{1}{2}$ mi. of centrifugally spun concrete pipeline leading from a small regulating reservoir to the Laguna Beach main near Corona del Mar. Five bids, ranging from a low of \$798,000 to a high of \$1,290,000, were received. The Ameri-

FIG. 3. Cutting Upper Half of Pipe With Acetylene Torch

FIG. 4. Pipe Cut at Old Weld Ready for Lifting From Trench With Crane

FIG. 5. Pipe Being Lifted at Free End for Removal From Trench

FIG. 6. Pipe in 90-Ft. Section Being Lifted From Trench

can Pipe & Construction Co. of South Gate, Calif., was the low bidder and received the contract. The work was to be completed by October 31, 1943.

The contractor started work on the removal of the pipe in January 1943. A very small crew with little expense removed 4000 ft. of the pipe which was supported on piers in a 6-ft. tunnel. The remainder of the line, one half in private right of way and the other in public highways or city streets, was in a trench with cover varying from 3 to 20 ft. (Figs. 1–2).

The contractor used two crews, one excavating mostly in private right of way in the San Gabriel channel with a 2½-cu.yd. dragline, and the other in public streets with a trenching machine. Care was taken in the excavation and removal of the pipe to protect it from damage. Small labor crews were used with each machine to remove the material directly over the pipe, to make cuts in old welds in sections varying from 30 to 120 ft. in the trench and into 30-ft. lengths for loading onto the trucks. As soon as the pipe was uncovered, a welder entered the open end of the pipe and cut the lower half of the next joint with an oxyacetylene cutting torch and cut the upper half of the joint from the outside. The pipe was then removed from the trench by the dragline or truck crane. To protect the pipe from damage during excavation with the dragline, the two center teeth were removed from the bucket (Figs. 3–4).

Good progress was made by the dragline, although at times, on the six crossings of the San Gabriel river, many boulders were encountered and pumping was necessary to dewater the trench to permit cutting of the pipe. In some sections it was found that the

Fig. 7. Stock of Salvaged Pipe in Yard Ready for Reconditioning

water in the trench facilitated the removal by floating the pipe when it was possible to dewater the pipe at low places in the line. Because of interference with utilities and restriction of space in city streets, excavation with the trencher progressed much more slowly than with the dragline. The removal of 56,000 ft. of pipe was completed on July 17, 1943 (Figs. 5–6).

Observations made at the trench during the removal of the pipe often revealed corrosion pits in the exterior of the pipe due to holes in the coating caused by the pipe resting on large rocks or boulders. In many cases it was noted that tree roots were deeply imbedded in the coating often extending through coating to the steel. Although the specifications under which the pipe had been installed required a sand backfill of 6 in. around the pipe, it is evident that in rocky material, asphaltic or coal-tar enamel coatings should be protected by a more positive exterior coating.

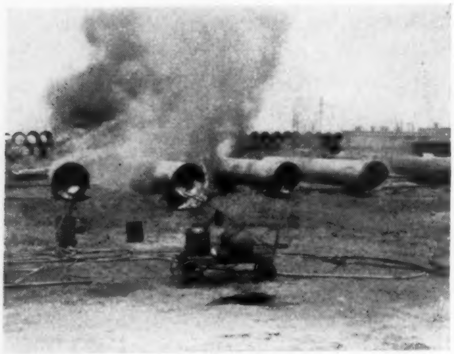


Fig. 8. Burning off Old Asphalt Coatings

As soon as the pipe was removed from the trench it was hauled on trucks a distance of 30 mi. to the contractor's plant at South Gate, Calif., for reconditioning. The contractor had set up a very efficient plant to do this work (Fig. 7). The specifications required

Fig. 9. Squaring Ends of Pipe With Cutting Lathe. Approximately ¼ in. was Trimmed From Each End of the Pipe

that the old coatings be removed, that the pipe be sandblasted and given a coal-tar enamel coating $\frac{3}{32}$ in. thick on the interior and $\frac{1}{8}$ in. thick on the exterior, with a $\frac{3}{4}$-in. gunite coating over the exterior enamel, and that the pipe be electrically welded in the field. Because of the scarcity of experienced pipeline welders, the contractor proposed a change of plan substituting a lock-joint assembly with rubber gasket in place of the welded joint, so that field welding could be reduced to a minimum. This change consisted of welding a steel ring on the spigot end

FIG. 10. Welding Spigot Ring to Pipe

with a groove for a round rubber gasket to fit against the bell of the adjoining pipe section. The welding of the spigot rings to the pipe was done at the plant.

Reconditioning of the pipe was started in June 1943, when the plant was ready to go on production. The first operation was to remove the asphaltic coatings by burning. Two burning racks, consisting of 2 steel rails spaced 18 ft. apart elevated about 18 in. above the ground, were used to support 6 sections of pipe, providing space for air circulation and for accumulation of the residue from outside coating as it dropped from the pipe which was heated internally. Torches using diesel oil were shoved through each pipe, burning the interior coating and heating the pipe so that the exterior coating sloughed off. Care was taken so that the heat from the residue on the ground did not overheat the pipe causing out-of-roundness or sagging of the pipe (Fig. 8).

Following the burning, two men with acetylene torches trimmed the rough edges of both ends of the pipe and removed the section of spigot left in the bell at the time the field cut was made. The ends were then squared in a lathe. Approximately $\frac{1}{4}$ in. was trimmed from each end of the pipe. This was followed by grinding the longitudinal welds smooth on the bell and spigot ends with an air-driven grinding wheel, 2 in. on the bell and 5 in. on the spigot. This was necessary for the belling operation and the welding of the spigot

FIG. 11. General View of Shotblast, Priming and Enameling Plants

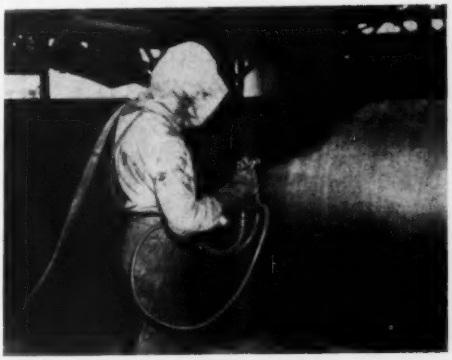


FIG. 12. Priming Pipe Preparatory to Enameling

Fig. 13. Application of Interior Enamel Lining. Note Troughs Entering Each End of Pipe and Kettles on the Right

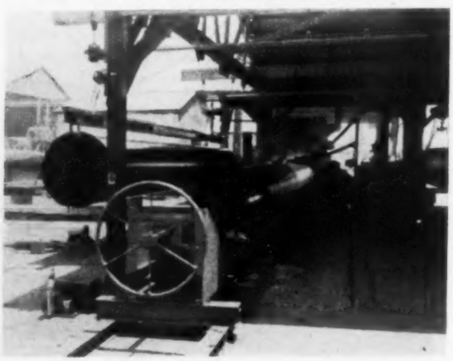


Fig. 14. Application of Exterior Enamel Lining

ring to the pipe as well as the joining of the bell and spigot in the field. Pipe out-of-round or dented was then put through a rolling machine such as is used for initial rolling of steel plates (Fig. 9).

The pipe was then sent to the welding rack where a new spigot ring was welded to each section of pipe. Welding of the spigot ring on the outside only was required on the larger number of sections. Both inside and outside welding, however, were required on 300 sections of $\frac{5}{16}$-in. plate where the pressure exceeded 240 psi. After welding on the spigot ring, the pipe ends were corrected for roundness and small dents by the use of a 50-ton hydraulic press. Following this, the pipe was belled to the required diameter of $37\frac{1}{8}$ in., which was $\frac{1}{2}$ in. more than the original bell. Then the pipe was subjected to a hydrostatic test pressure of 250 psi. for the double-welded and 150 psi. for the single-welded spigot rings. This test was not a part of the specifications, which required hydrostatic testing at operating pressures after installation of the pipe, but was necessary because of the use of shop-welded lock-joint rings in lieu of the originally specified lap joints welded in the field. The plant test revealed many leaks in the spigot ring welds, probably due to inexperienced welders. Leaky welds were chipped out, rewelded and the section retested (Fig. 10).

The pipe section was next put through the shotblasting plant (Fig. 11). Pipe was put on an electric-driven carriage with adjustable speeds rotating the pipe 8–10 rpm. and carrying it longitudinally across fixed nozzles 2 or 3 in. per revolution. Four $\frac{5}{16}$-in. nozzles were used, spaced 8 in. apart on both inside and outside of the pipe, operated at 65–110 lb. air pressure, using 50 per cent each of No. 30 and No. 50 steel grit. The time required for each pipe to pass through the shotblast depended on the condition of the pipe after burning of the original coatings. The average time in the shotblast was 25 min. As soon as the pipe was removed from the shotblast, an inspection was made and pits of depths $\frac{1}{16}$ in. or greater were marked out for welding. The interior was in excellent condition but the exterior showed appreciable pitting. Although an average of 6 small pits per section was found in 1878 of the 30-ft. sections, the steel was put in a condition almost as good

as new by welding the pits and grinding off the weld material to the face of the plate so that a uniform thickness of enamel could be applied (Fig. 12).

Most of the pits were found to be in the bottom of the pipe where the coating had been punctured by rocks and boulders. Many badly corroded sections were taken from the trench in the city of Monrovia where the soil was a decomposed granite. The large amount of corrosion found in the pipe in this area is contradictory to the general belief that the soils along the foothills west of San Gabriel canyon are noncorrosive.

Following the welding of the pits, both sides of the pipe were primed with coal-tar primer by use of spray guns fed from a 15-gal. pressure pot equipped with a continuously operating air-powered agitator. Sufficient space for 25 pipe was available to provide a minimum of 24 hr. between the priming and the application of the coal-tar enamel coatings. The enamel for the interior coating was heated to application temperature of 490° to 500°F. in four gas-fired kettles of $3\frac{1}{2}$ bbl. capacity each. The enamel was then transferred from the kettles to the pipe by means of two **V**-shaped troughs 15 ft. in length mounted on manually propelled carriages permitting entry from each end into the pipe revolving at 65 rpm. The pipe was rotated at this speed for 3 min. after dumping the enamel from the troughs. The interior coating had a thickness of $\frac{3}{32}$ in. with a permissible variation of plus or minus $\frac{1}{32}$ in. The $\frac{1}{8}$-in. thick exterior coating was then applied in two layers. The

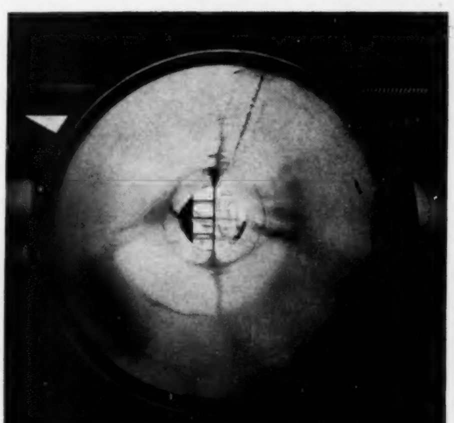


Fig. 15. Finished Enamel Coating Showing Electrical Sparker at Far End of Pipe

Fig. 16. Guniting $\frac{3}{4}$-in. Reinforced Mortar Coat Over Exterior Enamel Coating

Fig. 17. General View of Finished Pipe in Yard; Enameling Plant at Left

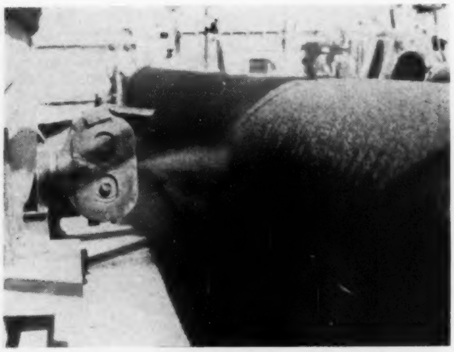


Fig. 18. Brush Coat Mortar Machine Perfected by Contractor Applying Mortar Coat in Lieu of Gunite

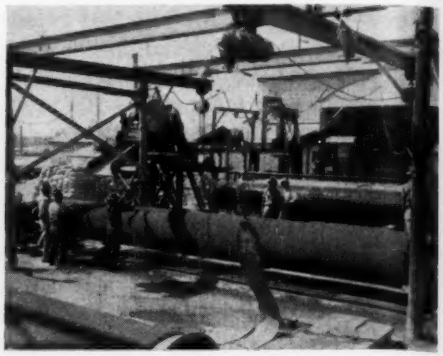


Fig. 19. Placing Wire on Mortar Coat Prior to Application of Second Coat With Brush Coat Machine

enamel, heated in two kettles of 5-bbl. capacity each, was applied to the exterior of the pipe from an electrically powered carriage traveling parallel to the pipe section at 7 fpm. while the pipe was rotated at 12 rpm. Two trips of the carriage were required to obtain the specified thickness. The pipe coatings were tested for holes or thin spots in the enamel with electrical testing brushes. One barrel of enamel weighing approximately 600 lb. was used per 30-ft. pipe (Figs. 13–15).

The contractor perfected an enamel cutting machine so as to eliminate considerable cutting by manual labor. This machine consisted of three cables rigged up to a 7.5-hp. electrically-driven winch. The cables were placed equidistant around a stripped drum of enamel and pulled through the drum, cutting it into four parts. These were then cut into smaller pieces with an axe for use in the kettles.

After enameling, the pipe was moved to the gunite rack where a ¾-in. coating of gunite was applied to furnish a protection to the enamel coating. In order to comply with the order of WPB that use of critical materials be held to a minimum, the District specifications required that the gunite be placed without reinforcing mesh. The contractor's operations revealed that unreinforced gunite could not be applied satisfactorily over the enamel. In June 1943 this condition was reported to the War Production Board and application for the use of 2-in. × 4-in. 13-gage steel mesh was approved by the Board for use in the gunite coating. Before applying the wire mesh, a flash coat of gunite ¼ in. thick was applied over the enamel to prevent the wire mesh from

Fig. 20. Truck Loaded With Four 30-Ft. Sections of Pipe Arriving at Trench for Installation

penetrating the enamel and impairing its insulating value. In order to keep up a daily average of 25 pipe sections, the contractor was required to use 2 gunite machines. This was due to the scarcity of experienced gunite men, for on previous work done by the District's contractor one crew accomplished the same amount of work (Figs. 16–17).

To eliminate labor problems, the contractor, at the beginning of the plant operations, experimented with a brush coating mortar machine to apply a mortar coating in lieu of guniting (Fig. 18). The mortar applied by this machine was a $3\frac{1}{2}:1$ mix with a water cement ratio of 0.61. The mortar was applied to a revolving pipe from a car traveling parallel to the pipe. Mounted on the car was a $\frac{1}{2}$-cu.yd. hopper, fed from an overhead mixer and a screw feed 5 ft. long having a 12-in. diameter

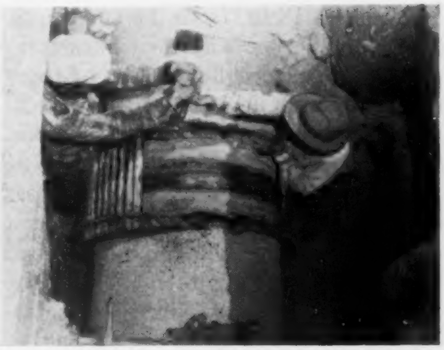


Fig. 22. Placing Form for Mortar Collar to Cover Enamel Coating at Joints

at the receiving end and 8-in. diameter at the discharge end, to which the mortar was fed manually. A 10-hp. motor operated the screw feed which discharged into a pair of oppositely rotating meshed 10-in. diameter steel brushes, 8 in. wide, traveling at a peripheral speed of 5000 fpm. These

Fig. 21. Pulling Pipe Into Place With Sling, Rachet and Cable

Fig. 23. Manhole Structure Salvaged and Installed at the Newport Bay Blow-off

brushes, set 18 in. from the surface of the revolving pipe with their axes horizontal, propelled a flat stream of mortar against the pipe revolving at 20 rpm. The thickness of the mortar coating was regulated by the speed of the traveling car. The $\frac{1}{4}$-in. flash coat was applied by operating the car at a rate of 9 fpm. The pipe was then wrapped with the wire mesh and the second coat of $\frac{1}{2}$ in. applied by operating the car at $4\frac{1}{2}$ fpm. A coating of excellent quality was obtained by this method which was used on one-third of the pipe sections.

Water curing of 14 days was required on all pipe after the gunite or mortar had been placed.

The installation of the pipe in the field did not offer any particular difficulties. Lack of experienced labor seriously retarded progress. The substitution of the rubber lock joint in place of the welded field joint expedited progress as experienced welders for pipeline work were not available. A few welded joints made in the field developed leaks, making it necessary to dewater the line, chip out the welds and reweld. The specifications required enameling of both the inside and outside joints. In order to obtain a satisfactory enamel coating on the outside unaffected by temperature changes before the pipe was backfilled, it was necessary to place bulkheads in the line at manholes spaced about 1500 ft. apart and fill the section with water to keep the change in temperature to a minimum. A flexible form was used for placing the mortar coating on the exterior of the joints after the enamel coating had been tested. Coating of the inside joints was done after the final leakage tests under operating pressure were made on sections of the line and the line dewatered. The tests revealed a loss 30 per cent of the allowable 500 gal. per mile of 36-in. pipe during a 24-hr. period (Figs. 19–23).

Reconditioning and Protection of Steel Pipelines in Place

By L. W. Grayson

A FEW years ago the Riverside Municipal Water Department developed a method for reconditioning and protecting some 5500 ft. of 36-in. and 1850 ft. of 30-in. steel pipe. These remarks, in general, apply to the particular conditions as found and observed during the reconditioning job which was carried on by the department.

The pipeline to be reconditioned was laid in 1927 and constructed of $\frac{3}{16}$-in. steel plate, having butt-welded longitudinal seams and lap-welded circumferential joints; it was protected externally by mesh reinforced gunite and internally no coating had been applied.

The first inspection made of the interior of this pipe in March 1936 gave evidence, generally, of mild tuberculation and pitting over the entire surface. The second inspection, made May 1939 at a different location, showed similar results and proved the advisability of proceeding with the work.

The footage of pipe reconditioned is of no great magnitude but the method of procedure and accomplishment is of some general interest. The specifications, as adopted by the Board of Public Utilities, required the department to install all necessary outlets to the pipe, to sandblast and furnish all ventilation and electricity for lighting, while the mechanical scraping and application of the protective coating were to be contracted. A contract was let to the Flexible Sewer Rod Equipment Co. on December 15, 1939, for the mechanical scraping of the pipe and a contract was entered into on January 12, 1940 with The Walter Ferem Co. for the application of the coal-tar enamel.

As this pipeline constituted the main feeder line between the largest distribution reservoir and the City, it was necessary that the work be completed in as short a time as possible and during the season of the year when light consumption might be expected. Thus the supply could be maintained by pumping from wells directly into the system, eliminating the major portion of the storage supply, as well as the main water source.

Eight-inch pass holes and 20-in. manholes were welded to the pipe while still in service to help minimize the outage time. A maximum distance of 1000 ft. between manholes, and 300 ft. between pass holes or adjacent manholes, was the standard. Flange construction was used in the design of these outlets and, in addition, reinforcing pads were welded in place around the manholes.

The pipeline was dewatered on Jan-

A paper presented on October 28, 1943, at the California Section Meeting, Los Angeles, Calif., by L. W. Grayson, Supt., Elec. Light and Water Depts., Riverside, Calif.

uary 15, 1940. The necessary cuts were made for the introduction of the mechanical scrapers and the installation of the necessary riser pipes, and on January 18, the first pass was made through the 36-in. pipe with the scraper. The scraper had to pass two 90-deg. ells in the route of the pipe—one a 36-in. radius, the other a 9-ft. radius. This was accomplished by means of a special pilot attached to the front of the scraper. Passing the short radius ell was completely successful, and it was decided, after subsequent inspection, that a second pass with the scraper would be advisable. A third leaf was added to each blade of the scrapers, thus increasing scraper tension.

After the two passes, all tuberculation was cleared away from the inside of the pipe and it was ready for the sandblasting.

In scraping the 30-in. pipe the same tools were employed except that smaller diaphragms were used on the pushers, one leaf of each scraper was removed, and the tool entered into the 30-in. pipe.

It was interesting to observe the pressure required to move the tool through the pipe—25 lb. to start the tool and from 20 to 25 lb. to keep it progressing satisfactorily through the pipe. Only one passing of the tool was required through the 30-in. pipe, due mainly to the increased pressure of the scrapers as used.

No attempt was made at any stoppage of the tools at the end of the pipe; they were allowed to come entirely free of the open end of the pipe. However, consideration was given to the admission of adequate air to prevent pipe collapse.

Having completed the mechanical scraping, the next step was to test the newly developed sandblasting equipment for mechanically blasting the interior of the pipe.

A rather poor start was made with the machine as first designed and after the second trial it was decided to alter slightly the method of abrasive feed in the machine. When these changes were completed, favorable progress was made on the blasting and satisfactory results obtained on January 27. On January 28, sufficient pipe was ready and the protective coating was started. This coating was standard water works coal-tar enamel protective coating, supplied by the Barrett Division, Allied Chemical & Dye Corp., N.Y., consisting of a first coat of primer, and a daubed coating of coal-tar enamel.

Good progress was made on the blasting which was completed on February 16. With the completion of the enameling on March 1, the subsequent return of the section of pipe to service took place on March 7.

The decision to do the mechanical scraping prior to sandblasting involved several factors. Insofar as the design of the shotblasting machine was such that it was self-contained to the extent of complete salvage of abrasive material within the pipe, and required only a hose line for compressed air and a cable line for electric power to run from the machine to the ground surface, it was desirable to remove, as much as possible, the foreign substances—mainly tubercules—from the pipe before blasting.

The anticipated cost of the mechanical scraping was far below the actual cost and required considerably less time than would be necessary to remove spent abrasive materials from the pipe. The development of the mechanical sandblasting equipment is no more than a desirable method of closer approach

to a satisfactory blasting job. One must remember that the surface to be blasted was not a smooth, flat surface as is encountered in the blasting of newly fabricated pipe, but carried pits, by actual measurement from the merest beginning up to and including one pit through the entire thickness of the steel wall, being $\frac{3}{16}$ in. in depth, with a majority of pits checking between .047 in. and .063 in. In the opinion of the officials of the department, as well as those from other water departments familiar with this type of work, however, completely satisfactory results of the blasting were obtained.

Economical Coating

It is felt, to a certain extent, that the greatest achievement was in successfully and economically coating the interior of a steel line in place, after a method which has been proven by its use on newly fabricated pipe but never before, insofar as we have been able to ascertain, to a pipe in place, and, at a cost of approximately 20 per cent of the replacement estimate.

The construction of the mechanical scraping device, as furnished by the Flexible Sewer Rod Equipment Co. of Los Angeles, was composed of six sections, each approximately 30 in. long and operating in the pipe in the following order: the pilot, a pineapple,* a pusher, two pineapples and a pusher. The center portions of each section were of fabricated steel approximately 10 in. in diameter with the end of each center section convex in shape to obtain flexibility. Attached to the front end of the pilot (radially) were spring steel bars to keep the front end of the device following, as nearly as possible, the center of the pipe and to facilitate the passage of the unit around the elbows. Three rings of flat spring steel scraper blades, the ends of which were ground to the curvature of the pipe, were attached to the center position of the pineapple. Attached to the front end of the pusher was one circle of single leaf scraper blades backed up with straight blades which, with special castings on the end of each straight blade, formed the actual support for the triple thickness rubber piston head, the center of which was supported by the center portion of the pusher.

As each unit of the scraper was placed in the pipe a flexible steel cable was threaded through the center and this cable attached to a truck was used to pull the units into place. After all units were installed in the pipe the cable was pulled through, snug against the front end of the pilot, and a heavy coil spring was then placed on the tail end of the cable and the various units secured together as one.

The water was then started into the line and as the head reached the required pressure, the machine moved forward. At all times the machine could be located as it worked through the pipe, by the sound and by slight vibrations of the ground surface which were very noticeable as the speed changed, traveling slightly faster on downgrades and slower on upgrades, due mainly to the load carried by the machine on the upgrades and by the water ahead of the machine on the downgrades.

There was no opportunity to determine the quantity of substances removed from the pipe as the afterflow of water carried practically all into storm drains. But in the water flowing

* A colloquial term to describe a pineapple-shaped portion of the cleaning unit which is designed to develop the forward thrust of the equipment.

on the street surfaces immediately adjacent to the pipe discharge end, the refuse was approximately 6 in. deep over quite an area.

Efficient Equipment

In general, the design of the sandblaster consisted of a specially designed pressure hopper, mounted near the center of the apparatus, containing the abrasive material under pressure. Two U.S. Vari-Drive, 1-hp. 3-phase electric motors furnished the motive power and were mounted base to base near the back of the machine; one motor being used to propel the machine, and the other to rotate the revolving nozzle.

As the travel of the machine at a low speed meant considerable gear reduction, the final drive was made by attaching a chain to a front wheel. Likewise, the nozzle, consisting of a revolving bracket journaled on a fixed hollow shaft, was driven through the necessary gears by chain, thus rotating the bracket, causing flexure of the hose and controlling the striking angle of the abrasive traveling in a helical path on the pipe surface. A standard $\frac{3}{8}$-in. Norbide-Pangborn blasting tip, mounted in a special holder and bearing which allowed the tip to rotate freely in the bracket, was used in the revolving nozzle.

It is readily understood that by the use of Vari-Drive motors, the travel speed of the carriage as well as the rotating speed of the nozzle, could be changed to meet conditions that existed in the pipe, making it possible to obtain very satisfactory results with a high degree of efficiency.

From the machine to the surface equipment a 1-in. air hose and a 6-conductor cable were used and fed to the pipe from a construction shack, as the machine progressed in the pipe. The 6-conductor cable allowed sufficient conductors for lighting at the machine as well as adequate signal system and positive grounding.

Time Element

A 210-cu.ft., inner-cooled, two-stage air compressor supplied the air through an auxiliary cooling coil and a moisture eliminator to the equipment. As each section was blasted, the cable and air hose were disconnected from the machine and pulled from the pipe at the same time being returned to the construction shack, and thus with the compressor and other equipment moved forward to the next outlet.

The minimum time required for this move, from the time the machine stopped until it was again in operation, was found to be approximately 30 min., with an average time of approximately 45 min.

Working Schedule

The blasting was carried on over a 24-hr. schedule, composed of three shifts working five days a week, each shift consisting of four men: one man in general charge; an operator, operating the sandblast machine traveling on a small dolly trailer with the machine in the pipe; a loader working in front of the blaster and reloading the spent abrasive material to the hopper after each successive run; and a tender whose duties consisted of taking care of the compressor and other surface equipment.

Due to the injector action of the release of compressed air within the confines of the pipe, no ventilation was required while blasting. It was necessary, however, to ventilate during loading periods, particularly in case of reverse air currents. It was necessary that the loader be equipped with ade-

quate dust respirator and gas-type water goggles, and that he wear coveralls banded at the ankles and wrists and fitting fairly snug at the neck.

Daily footage blasted varied with the number of moves and amount of material removed, with a maximum during any 24-hr. day of 784 lin.ft. of 36-in. pipe, an average throughout the job of 20 ft. per hr., including the time of hand blasting of elbows and other specials. This resulted in a cost considerably below the normal blasting charges and at the same time gave a uniformity of work almost impossible to achieve by any other available method.

Dust Nuisance

Throughout the entire work of blasting, 50-mesh angular steel grit was used with a total of 2700 lb. for the 54,000 sq.ft. of surface blasted. The amount of reclaiming was exceedingly high; for each square foot blasted, 5 lb. of steel grit were used, and an actual loss of 1 lb. per 20 sq.ft. of area blasted, or a recovery of 99 per cent.

As the blasting progressed along the pipe, the work was carried into fully improved residential property, and it became apparent that the dust carried from the pipe by the air would become a nuisance. In order to eliminate this, a 12-ft. square $\times$ 6-ft. high frame was built with papered roof and a cloth mesh on four sides, with a water spray to keep the cloth mesh washed. Hence, it was possible to trap approximately 75 per cent of the emitting dust and carry it away with the water stream. Heavy dust accumulated in the invert of the pipe, at times in excess of 2 in. in depth, and had to be removed at intervals varying from 12 to 24 hr. At the same time a complete change of abrasive material was made so that the excess dust might be removed and the abrasive returned cleaned into the machine.

The specifications for the coal-tar enamel and primer were, in general, the same as the standard A.W.W.A. specifications 7A.5–1940 for coal-tar protective coatings for steel water mains, as specified under Type A Coal-Tar Enamel. It was found advisable to place a minimum time of 24 hr. after application of the primer, prior to enameling.

The enamel for the line was heated by the usual method of closed portable enamel kettles to a temperature of 525°F. It was then drawn into insulated buckets and carried to the adjacent pass hole where specially designed funnels were used, enabling the passer inside the pipe to hook the receiving bucket to the lower end of the funnel. The hot enamel was poured through the funnel to the bucket in the pipe and passed to the enamelers. Two enamelers, two passers and one kettleman made up the crew.

The enamel was applied to the primed surface of the interior of the pipe with Tampico daubers in a progressive, shingle fashion, using longitudinal strokes so that each row of brush strokes overlapped those of the preceding row as well as the preceding stroke, with the finish coat having a minimum thickness of $\frac{1}{16}$ in. The enameling completed the interior surface was tested for pinholes and voids by means of an electrically energized detector brush. All holes found were repaired, followed by a second test with the electrical detector and a successive patching of openings through the enamel.

The ventilation for the application of the enamel was accomplished by means of bulkheading the section

where the enamelers were working. Bulkheads were made of a diaphragm of waterproof canvas, supported and held by an inflated inner tube, after which electrically-driven blowers, two per section, of 1200-ft. capacity each, furnished the necessary amount of ventilation.

An excessive, as well as an insufficient, amount of air apparently bothered the enamelers. This was due to the high velocity which drove the smoke from the enamel into their eyes and faces.

After the enameling was completed, the line was thoroughly cleaned of all loose foreign substances, flushed and filled with heavily chlorinated water, maintaining a high residual at the end of 20 hr. The line was again flushed and returned to service. After the main was returned to service the disturbed and removed sections of the gunite exterior coating were replaced.

Because anticipated atmospheric temperatures were expected to range from the low 30's to the high 90's, it was necessary that the surface of the pipe, during the period from the time just prior to blasting until the application of the enamel, be kept free of moisture. Although there was considerable rain during the course of this work, no trouble, due to condensation within the pipe at any time, was encountered. Nor was the work delayed because of weather conditions; it was only necessary to build temporary shelters for the blowers, the open outlets to the pipe, the enamel kettles and other appurtenant equipment.

To observe the reaction of time on the project, several water works officials and engineers from southern California, made an inspection of a section of the pipe on May 16, 1941. The opinions resulting from this inspection were that the enamel appeared to be in the same condition as when applied, apparently maintaining an extremely good bond to the pipe surface and giving every indication of insuring the reconditioning work as a method satisfactory to prolong the useful life of the pipeline so treated for a period of many years.

Since the completion of the Riverside job, the work of reconditioning in place some 4800 ft. of 42-in. riveted steel line has been completed for the California Electric Power Company, substantially the same treatment as outlined above with the exception of the preliminary cleaning prior to the blasting operation. This was accomplished by manual labor using scrapers and flushing the residue from the pipe at frequent intervals.

It was the writer's privilege to be in charge of the work from the preliminary inspection of the line through the completion of the reconditioning, and to enjoy the interest displayed by other water works men during the various stages of the work. Their opinions indicate that we should expect satisfactory results from the completed work, having been able to secure satisfactory bond to the steel surface coated by the rather novel method of sandblasting.

Sincere appreciation is expressed to Mr. Harry Hayes, Asst. San. Engr., Bur. of Water Works & Supply of the Dept. of Water & Power, City of Los Angeles, who, at the time of the reconditioning work, was in charge of the protective pipe coating laboratory of the Specifications Section for the Bureau; and to the members of his staff, for their valuable assistance in carrying out this work.

Field Removal of Asphalt Lining and Coating From 24-Inch Steel Pipe

By Carleton V. Bascom

THE work to be done consisted of getting some 4100 ft. of 24-in. id. steel pipe out of the ground and cleaning it, inside and outside, preparatory to blasting and enameling.

The pipe had been in the ground for 12 yr. and the asphalt coating and lining were still live and resilient enough to become soft and gummy in the sun. However, an application of whitewash to the outside of the pipe was found to have sufficient cooling effect to keep the inside asphalt lining hard and brittle. The pipe to be cleaned had been fabricated in 60-ft. lengths, of $\frac{3}{8}$-in. plate with a lateral weld. The 60-ft. lengths were composed of two 30-ft. lengths with a connecting slip joint shop-welded; the field joints being bell and spigot and calked with cement. To remove the pipe from the trench, the cement joints were broken by raising and lowering the free end of the 60-ft. length several times. This method did not injure the bell or spigot and was much more economical than chipping the joint.

After removing the pipe from the ground, the old asphalt coating was scraped from the outside by use of hand scrapers. The pipe was then cut into 30-ft. lengths by cutting with acetylene torch through the slip joint shop weld, thereby saving the joint for refabrication.

The machine for removal of the inside lining was built on a frame consisting of a 28-in. piece of 18-in. di-

FIGS. 1–2. Apparatus for Removing Old Inside Lining From Pipe

A paper presented on October 28, 1943, at the California Section Meeting, Los Angeles, Calif., by Carleton V. Bascom, Dist. Engr., San Fernando Valley Section, Water Distr. System, Los Angeles Bur. of Water Works and Supply, Van Nuys, Calif.

ameter pipe. Sharp-edged wheels were set at the lower third of this pipe frame at the front and back ends. These wheels cut into the old lining or incrustation, helping to prevent the frame of the machine from turning in the pipe. It was found necessary to add about 100 lb. of lead on the side of the frame as an added counter-balance against turning (Figs. 1–2).

The six scrapers used were "Borium" tipped for hardness and stagger-mounted on individual lever arms. These lever arms were pivot mounted, three on each of two rotating discs. The free end of each lever arm was provided with a spring to hold the scraper against the pipe surface. Rotation was supplied by a pneumatic air drill, piston type, rated at 420 rpm. This drill was mounted in the center of the pipe frame and was connected directly to the shaft and discs.

Holes were drilled at proper points in the discs for the insertion of pins to hold the lever arms away from the pipe as it entered the machine.

A tugger to pull the cleaning machine through the pipe was provided, consisting of a wheel-mounted winch with $\frac{1}{4}$-in. cable, and driven by an air motor of the same type and capacity as used in the pipe cleaning machine. A standard 115-cu.ft. portable compressor supplied the air.

Figs. 3–4. Cleaning Machine was Run Through the Pipe Twice

Crew

The crew for cleaning the inside of the pipe consisted of four men: a compressor operator, cleaning machine operator, tugger operator and a hoist operator. The hoist operator was on the job to load pipe on the trucks and filled in his spare time by moving the cleaning machine from one pipe end to another. Had the hoist not been available the cleaning machine would have been carried by using the tugger which is designed for use as a hand truck.

Operation

The machine was entered in the pipe; the holding pins were then pulled and the air turned on, starting the cleaning motor. The speed of operation of the cleaning motor was con-

trolled by the compressor man with a valve at the compressor. The rate of travel of the cleaning machine through the pipe was held to about 2 fpm. by the tugger operator, as this was the best speed at which a fair job could be done. At the end of each length the machine was turned around and run through a second time in the opposite direction at the same speed. This procedure removed the lining from each side of the lateral weld and insured a clean pipe throughout.

Cost

The time consumed in removing the lining and coating amounted to 1246 man hr., about equally divided between inside and outside cleaning. The total cost was $2577 and for the 4100 ft. this amounts to 62¢ per lin.ft. The removal of the pipe from the ground and its subsequent transportation were not included in these costs.

Asphalt can be burned from pipe but there is the danger of warping and other disadvantages. The method described is particularly applicable where the asphalt dip is still fairly fresh and resilient. It is impractical to blast such a surface due to the adhering of the asphalt to the grit.

Specification Requirements for Reconditioning and Strengthening Used 44-Inch Steel Pipe for Permanent Installation

By Fred D. Pyle

THE Federal Works Administration is now installing for the use of the City of San Diego the 22,000-ft. San Vincente pipeline from San Vicente Dam to a connection with the El Capitan pipeline at Lakeside. This pipeline will be used to transfer water from El Capitan Reservoir to San Vicente Reservoir to keep the reservoirs in balance in such a manner that they will spill at the same time; and to deliver water from San Vicente Reservoir back to the El Capitan pipeline for delivery to the City.

The maximum head on the San Vicente pipeline is about 400 ft. and the minimum head 300 ft.

The War Production Board would not approve construction of a reinforced concrete steel cylinder pipe of 48-in. diameter as originally planned, but did approve the construction of the pipeline on the basis of using 44-in. steel pipe to be salvaged from San Francisco's obsolete Corral Hollow pipeline.

The salvaged Corral Hollow pipe to be installed will consist of about 18,560 ft. of $\frac{1}{4}$-in. plate, 2340 ft. of $\frac{5}{16}$-in. plate and 360 ft. of $\frac{3}{8}$-in. plate. About 40 ft. of $\frac{1}{2}$-in. plate pipe will be used in making specials.

The FWA purchased the pipe in place in the ground from the City of San Francisco and arranged for the removal of the pipe from the ground and its shipment to the yards of the American Pipe & Construction Co. in South Gate for rehabilitation, treatment and installation of the pipe in accordance with specifications prepared by the City of San Diego.

Specifications

General. The specifications provide for the excavation and backfill, rehabilitation treatment and installation of the pipe and the furnishing and placing of specials, fittings, valves and appurtenances complete in place in working order. The specifications, except for the rehabilitation and treatment incident to the use of Corral Hollow pipe, are the same as used by the City of San Diego for several years. The contractor is responsible for unloading, hauling and storing the pipe as delivered by FWA.

Removing Coating and Squaring Ends. The contractor is required to remove all existing coating from the

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inside and outside of the pipe without damage to the metal. The methods to be used include burning, sand- or shot-blasting and such other operations as may be required to remove completely the coating to the base metal with no residue which would interfere with the bonding of mortar to be applied. Where necessary, the ends of the pipe are cut at right angles, or at such other angles as required, and ground or chipped.

Repairing Pipe and Utilizing Short Sections. Where required, the contractor is to repair pits, cracks, holes and other defects by electric arc welding and by patching, and to sever unsatisfactory portions of the pipe. Short sections are to be assembled to standard length sections of about 30 ft.

Joints. Each section of pipe is to be constructed with a self-centering expansion bell and spigot joint to be sealed with a rubber gasket. The bell is to be formed by expanding the end of the pipe cylinder and the spigot is to be formed by welding to the cylinder a special rolled section of steel having a groove for holding the rubber gasket.

Reinforcement. The contractor is required to reinforce the pipe cylinders by winding directly on the cylinder, steel rods to the extent necessary to make the total steel in the cylinder and the rods, sufficient to provide the cross sectional area of steel in one wall per lineal foot of pipe as indicated on the drawings. The steel rods are required to form a complete loop at each end of the cylinder and extend to within $1\frac{1}{2}$ in. of the end of the completed section and to be welded to the cylinder at the ends and at intermediate points to maintain spacing. Spacing of rods is to be not less than $1\frac{1}{2}$ in. and not more than 4 in. and rods welded to outlets and manholes.

Mortar Lining. The contractor is required to apply a $\frac{3}{4}$-in. spun cement mortar lining to the inside of the pipe with a tolerance of $\frac{1}{8}$ in. either way.

Exterior Pipe Coating. The contractor is required to apply a 1-in. cement mortar coating to the outside of the pipe and, where the reinforcing rods are larger than $\frac{3}{8}$ in. in diameter, the thickness of the coating is to be not less than the diameter of the rod plus $\frac{5}{8}$ in. The mortar coating is to be applied by gunite process or by impact from revolving brushes.

Hydrostatic Tests. The contractor is required to apply the usual hydrostatic tests in the shops after completion of the joints, and in the field before completion of backfill.

Specials. The contractor is required to fabricate all bends and special angles from salvaged pipe of such thickness that no reinforcement is required. The lining is to be applied by hand and the coating by gunite or other process.

Payments. In general, payments are to be made on the unit basis. The payments for pipe are to be made on basis of the pipe completed and in the plant yard; the contractor is to furnish all materials except for the salvaged pipe furnished by FWA and broken down into classes according to the thickness of cylinder and amount of reinforcing required. Payment for loading, hauling and installing pipe is to be based upon length of completed pipe in place, irrespective of the varying amounts of reinforcement in the pipe. Payments are also provided (on the hourly basis) for time of a welder, equipment and supplies used in repairing salvaged pipe and (on the unit basis) for shop-welded circumferential seams for assembling short pieces of pipe into standard lengths.

San Diego's Experience in Cement Lining of Cast-Iron Pipe in Place

By Fred A. Rhodes

THE need for an adequate supply of water for fire protection was brought to the attention of the Water Distribution Department by a brush fire in the summer of 1942, and an investigation was started to determine the cause. The territory was in a residential district almost entirely built up and receiving water service through cast-iron pipes under paved streets. All of the service mains running north and south were supplied from a 16-in. feeder main which in turn was fed from a 125-ft. standpipe located at the southwest corner of the territory under scrutiny.

There were 11,290 ft. of 4-in. and 7115 ft. of 6-in. cast-iron pipe in the gridiron system. The blocks were 300 ft. by 600 ft. with a ¾-in. service every 25 ft. The pipe was installed from 16 to 30 yr. ago and had an average age of 25 yr. Some of the pipe was badly graphitized and cuts in the lines showed excessive tuberculation.

Some remedial action was necessary—either the existing lines must be taken up and new pipe installed or the Tate Pipe Lining Process used. Estimates of cost and the necessity of conserving critical materials weighed in favor of making the lining in place.

The pipe was in poor condition and it was feared it would fail in many places during the process of lining. Bids were called for the lining with the stipulation that the contractor furnish all labor, equipment and material to do that portion of the work. The Water Distribution Department had to undertake the following: (1) break the pavement over each service; (2) excavate to the service; (3) haul away the adobe soil; (4) lay a 2-in. high line for local service; (5) disconnect services and connect to high line; (6) remove all valves, hydrant services and hydrants; and (7) cut out sections of pipe to provide load holes for the lining process.

The contractor then proceeded with his work as follows:

Preparatory Work

Removed corporation cocks and screwed plugs into holes. Plugged all legs of tees and crosses with regular pipe plugs and provided shackles to hold them.

Cleaning Pipe

500-ft. sections of 4-in. or 400-ft. sections of 5-in. were cleaned in one operation.

The sewer rod was threaded through

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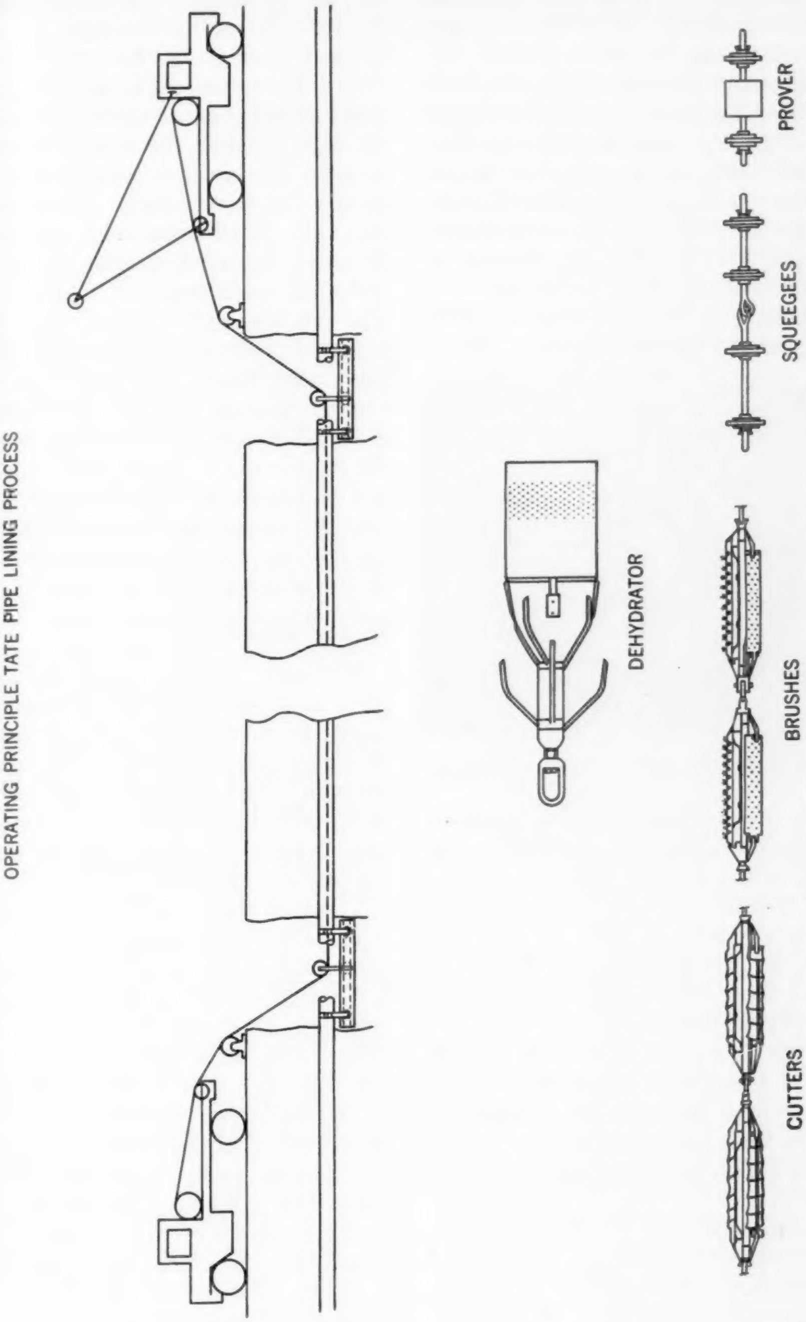

FIG. 1. Employed by San Diego Water Distribution Dept., in Lining Cast-Iron Pipe in Place.

pipe with the aid of a small machine which rotates the rod. The cable was attached to the end of the sewer rod.

The sewer rod was withdrawn, thus threading the cable through the pipe. The cable was then attached to truck winches stationed at each end of the section to be lined, to be used as needed. The trucks were tied down by chains to a gad driven into the pavement or to the main pipe at a service hole or a load hole. The winches were equipped with special friction clutches.

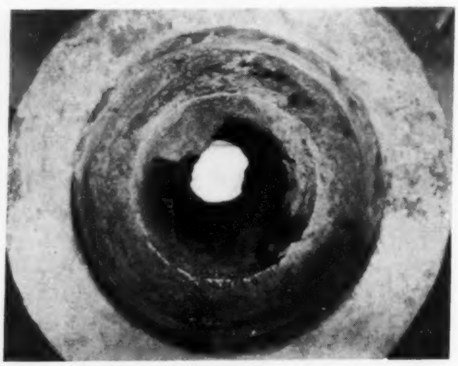

FIG. 2. Example of Pipe Before Cleaning

The cable which had been threaded through the pipe was attached to the winch at the opposite end of the section. Two cutting tools and one brush were attached to the cable. Water was placed in the pipe ahead of cutting tools. The tools were then drawn through the pipe.

At the other end of the section, the tools were reversed, more water added and the tools hauled back through the pipe in the opposite direction. These cutters and brush break up the tubercles.

Cutting tools were then removed and a flexible hydraulic type cleaner and two brushes were attached to the cable and drawn through. Water was continuously fed through the pipe during the cleaning. The 4-in. flexible cleaner was pulled through by cable while the 6-in. flexible cleaner was forced through by 50 lb. of water pressure. This process effectively cleaned the pipe down to the original metal.

After the flexible cleaner was removed, circular rubber discs and a prover, a metal drum with an outside diameter the same as that of the dehydrator, were attached to the cable. The circular rubber discs were $\frac{1}{4}$ in. larger than the inside diameter of the pipe and acted as squegees. Water was placed in front of and between the discs. These were then drawn through the pipe.

The prover was then removed and the discs drawn back and forth through the pipe several times until the interior of the pipe was dry.

Lining Process

Materials: Victor cement and Monterey sand were used, the mixture consisting of 1 of cement and 2 of sand. Mortar was hand-mixed in a large shallow pan. Each batch was given slump tests, until slump was $8\frac{3}{4}$ in. for 4-in. pipe or $8\frac{1}{2}$ in. for 6 in. pipe, before being put into load pipe.

The load pipe, a steel tube the same size as the pipe being processed and extending 12 ft. above the main, has a 90 deg. bend at the lower end and is attached to the main by a Dresser coupling. The cable was passed through the load pipe and mortar was placed in the load pipe by filling buckets at the mixing pan and passing them up to the staging built around the loading pipe, and dumped. When the load pipe was filled with mortar, the plunger attached to the cable was drawn down to force mortar into the pipe. The plunger was pulled down 8 to 10 times to place full charge into the main.

Enough mortar was placed in the pipe to make a complete lining and to extrude 10 to 15 ft. of mortar at the end of the lined section.

The load pipe was then disconnected. The cable, which had been withdrawing the loading plunger, was detached from the back winch and the dehydrator—a bullet-shaped instrument with steel runners to keep it centered and a series of small holes through which the mixing water escaped as it squeezed the mortar to the sides of the pipe—was attached and carefully entered into the pipe. Mortar was packed around it and worked into the pipe by the workman's fingers. This action removed all air from the entrance and insured the entrance end of the pipe a perfect lining. The dehydrator was pulled through the pipe at the rate of 8 fpm.

Pulls were made in 250-ft. sections for 4-in. pipe and 400-ft. for 6-in. pipe.

Principle of Operation

1. Friction of mortar against wall forces mortar around the dehydrator.
2. Taper of dehydrator compresses mortar.
3. Mixing water is forced from mortar through holes in skirt of dehydrator.
4. Water falls to bottom of pipe where it forms a flat segment in the pipe.
5. The owners of the system state that actual tests made with pressure gages installed in pipe wall showed a pressure of 130 psi. as the dehydrator passed by.

Hydrant services and other short lengths were connected by means of dresser couplings and lined on the surface of the street by cable. Fittings and hydrant ells were lined by hand.

Plugs were removed from corporation cock holes and from outstanding legs of tees and fittings after initial set was started. The excess mortar was removed and the lining hand-finished by a spatula.

Upon completion of one or two blocks of lining, the Water Distribution Department proceeded with the finishing work: (1) cleaned all corporation cocks and replaced same in tap holes; (2) replaced pipe at load holes, using solid sleeves; (3) replaced valves, hydrant services and hydrants; (4) flushed the line thoroughly; (5) reconnected the services; (6) restored the line to service in from

Fig. 3. Pipe After Cleaning

12 to 24 hr. after being lined; (7) moved the high line ahead in 180-ft. sections; (8) tied each end of a section under a truck and placed boards beneath high line where it sagged to pavement; (9) backfilled holes with sand or sandy loam; and (10) repaved the cuts in pavement with cement concrete or asphaltic concrete as required.

The manpower required of the Water Department was 2 foremen and 21 workmen. The equipment required: 1 compressor, 2 dump trucks, 2 crew trucks and 2 sump pumps. The mate-

rial used: 285 ft. of 4-in. cast-iron pipe, 120 ft. of 6-in. cast-iron pipe, 3 defective tees replaced, 4 additional gate valves installed, 120 4-in. sleeves, 40 6-in. sleeves, 3000 lb. of lead, 6700 sq.ft. of pavement, and four 8-in. × 4-in. reducers installed.

Difficulties Encountered

Some of the 6-in. pipe was found to be $6\frac{1}{4}$ in. inside diameter. This caused a small portion of the lining to collapse, since sufficient compression could not be obtained with the dehydrator which was $5\frac{5}{8}$ in. outside diameter. It was designed for a $\frac{3}{16}$-in. lining for a 6-in. pipe. This difficulty was overcome by using a drier mix.

Several sections of 6-in. pipe were found to have an inside diameter as small as $5\frac{1}{2}$ in. These reductions in diameter occurred just back of the hub end. These sections had to be removed.

Other imperfections, such as globules of iron and ridges or seams on the inside, were encountered. These prevented the prover from passing through, so it had to be removed before inserting the dehydrator. In the 6-in. pipe, a grinder, which had been developed in Oakland for removing imperfections in casting, was used. A grinder was built in San Diego to grind out the protuberances in 4-in. pipe. The grinding wheel was powered by an air motor which was inserted into the 4-in. pipe. The grinding wheel was offset so as to grind at one point. The grinder was pulled into the pipe until it met the obstruction and then the mortor was started. We had occasion to use this grinder twice and it worked satisfactorily.

Large pieces of lead, due to faulty yarning when originally laid, had to be removed by cutting the line. Poorly aligned joints accounted for two cuts. On three occasions, small pebbles were found lodged in the pipe.

These uncharted difficulties caused delay and expense. Twenty-eight separate obstructions had to be cut out; each cut-out required 4 hr. The excavation and cutting were the responsibility of the Water Department. The contractor complained about his lost time. We concluded that a royalty arrangement for the use of the equipment would be preferable to having two organizations on the job.

Another difficulty was the location of the 6-in. main. Most of it lay within 4 ft. of the streetcar tracks, and in one street, the pipe was under the end of the ties. Laborers excavating were compelled to jump out of the hole every three or four minutes to let a car go by. The equipment was offset to permit clearance for streetcars, the cable being aligned with a snatch block. Some sections of the track were put out of service for short periods, and on some sections, cars were slowed down to reduce vibration and give the lining time to set.

It was estimated that it would take 75 days to complete the work and it actually took 120 days. The contract price was 70¢ per ft. for 4-in. and 78¢ per ft. for 6-in. pipe. The Water Department work was estimated at about 80¢ per ft., but it actually cost \$1.13 per ft. New pipe would have cost about \$3.70 per ft., and the rehabilitation has cost \$1.86 per ft., or about 50 per cent of the cost of a new line installed in the same location as the existing line. The cost of \$3.70 per ft. would include hand excavation of the old line, its removal and replacement with a new line properly tapped, backfilling and repaving the street.

The specifications called for a coefficient "C" in the Hazen-Williams formula of 120. It has been exceeded, with one exception. Fire hydrant flow tests between 8:00 A.M. and 5:00 P.M. showed an average increase on all hydrants of 30 per cent. Hydrants at the extreme north end of the district, however, showed an increase of 55 per cent.

A badly graphitized pipe has been salvaged by the cement lining at a time when salvage is important.

A marked improvement in the taste of water delivered through the lined mains has been noted.

Better pressures are now maintained during periods of heavy consumption and better fire protection is now assured. It is anticipated that high carrying capacities will be maintained over a long period of time.

Savings to the amount of 30 per cent could be effected should the Department undertake further work of this nature

I wish to extend recognition for assistance in preparation of this paper to Mr. Earl Thomas, Supt. of Water Distr., and to Mr. Richard O. Stevens, Jr. Hydr. Engr. of the Department.

Discussion

L. L. Farrell[1] and W. R. McLean[2]

THE experience of the East Bay Municipal Utility District compares very closely with the city of San Diego's experience in lining cast-iron pipe with the Tate Pipe Lining Process. The methods of placing the lining including equipment and crews were identical. However, as local conditions varied from the city of San Diego the following comments can be added to Mr. Rhodes' paper:

From August, 1938 to January, 1943, the District carried on a program of cleaning cast-iron mains in the city of Alameda. These mains were laid during the years from 1880 to 1900 and the condition of the inside of the pipe was known to be poor. Flow tests made on the mains during 1938 before cleaning, showed a value of "C" equal to 65 in the Hazen-Williams formula. After cleaning, subsequent checks showed values as high as 101 for the same lines. Two and one-half years later a recheck was made of the same mains and the value of "C" had dropped to 68. At this time the mains were again cleaned and subsequent flow tests showed that the value of "C" had again been raised to 115. Rechecks were made of the mains during July, 1942 and January, 1943. The results showed a value of "C" of 107 in July and 75 six months later in January. These data verified all previous conclusions that cleaning alone was not permanent. The cost of cleaning the mains had averaged about 6¢ per foot per year.

During January, 1943 increased demands in an area in West Oakland showed that several of the mains were in need of cleaning. With the experience of the cast-iron main cleaning in the city of Alameda it was decided to try the Tate Pipe Lining Process and line several of the worst lines. Subsequently, a contract was awarded for lining 7762 lin.ft. of 6-in. cast-iron pipe and 3431 lin.ft. of 8-in. cast-iron pipe.

[1] Supt. of Construction and Maintenance, East Bay Municipal Utility Dist., Oakland, Calif.

[2] Field Engr., of East Bay Municipal Utility Dist., Oakland, Calif.

These mains had been installed during 1894 by one of the early water companies and the records of the lines were very meager. The area in which the lines were situated was a semi-industrial district, filled with old residences, schools, industries and one large Federal Housing Project consisting of two-story apartments. The grid consisted of 4-in., 6-in. and 8-in.

Figs. 1–2. Method of Handling Service Taps During Repairs to Main

mains. The 6-in. and 8-in mains are the trunk lines laid on the east and west streets and the 4-in. mains laid as the connecting mains on the cross streets. Many of the intersecting 4-in. mains were not gated on the larger main and to prevent shutting down large areas it was necessary to install gate valves on many of the 4-in. lines. Twenty-three gate valves were installed in the grid for this purpose.

The fire hazard in the area was great. Most of the fire hydrants and large consumers were on the 6-in. and 8-in. mains and extreme care had to be taken during the lining operations to prevent removing too many fire hydrants from service or shutting off automatic sprinkler systems.

During the lining operations a 2-in. line was sufficient to maintain service. In two cases, however, it was necessary to lay a separate 2-in. line to serve an individual consumer. One case was a large school and the other a Federal Housing Project which was served through a 4-in. meter. On this latter service a recording flow meter was set up to check peak demands and determine the size of pipe necessary to supply the service.

Prior to all lining operations a large-scale strip map was prepared of each main to be lined. This map showed all gate valves, intersecting mains and location and size of all known service connections. Upon this map was shown all cuts to be made and location and size of tap for the temporary main. Copies of the map were given to the contractor, foreman of the district crew and engineer on the job. The map proved to be of considerable help in co-ordinating the operations of the contractor and district forces.

About 1500 lin.ft. of 2-in. pipe were made up with two 2-in. × 2-in. × $\frac{3}{4}$-in. tees at each 20 ft. section. Each tee had a $\frac{3}{4}$-in. curb cock and a $\frac{3}{4}$-in. Chicago air hose coupling for service connections. The pipe was made up in 100-ft. lengths with unions for convenience in moving. About 300 ft. of 2-in. pipe were used for each operation. The connections for the service taps were made of $\frac{3}{4}$-in. air hose with a $\frac{3}{4}$-in. Chicago coupling at each end.

At first, during the lining operations,

all tees and crosses were removed from the line and lined by hand. This was later found to be unnecessary and all these fittings were later lined with the regular operation by placing a loose fitting plug in the outlet. After the dehydrator had passed through the fitting the plug was removed and the lining trimmed by hand.

On the 8-in. main 8 obstructions had to be removed within the first 1000 ft. These obstructions consisted of globules of iron ½ in. high and 2 to 3 in. long projecting into the pipe. These caused delays to the contractor and district forces and accounted for the high cost on the 8-in. pipe. No obstructions such as these were found on the 6-in. pipe and only two obstructions had to be cut out of the pipe. These two were due to poor alignment of fittings. One gate valve of which there was no record was found in the 8-in. main.

Conclusion

Although the cost of the lining operations were higher than estimated, better pressures and better fire protection are now maintained within the area during periods of heavy consumption.

Many of the fire hydrants within the area had been connected to the mains with a 4-in. cast-iron pipe. During the lining operations all of these fire hydrants were changed over to 6-in. pipe. Operating conditions within the area were also improved by the additional gate valves installed. The changing of the fire hydrant lines and installation of the gate valves probably would not have been done for many years, but while the lining operations were in progress the cost of doing this additional work was small. The cost of changing the fire hydrants was paid by the City of Oakland. Installation of the gate valves was charged to main extensions as a part of capital expense. These costs do not appear in the cost of the lining.

The writers agree with Mr. Rhodes that a royalty arrangement for the use of the equipment would be preferable to having two organizations on the job. Delays due to unknown obstructions caused the contractor much lost time, and could have been prevented by the use of only one crew. In addition, many times district crews were prevented from shutting down additional sections because of the need for fire protection, until the preceding section was again in service. This also caused the contractor some delay.

TABLE 1

Flow Coefficients of Mains—"C" Before and After Cleaning and Lining

Size—In.	Year Laid	Before Lining	After Lining: Based on Reduced Area	After Lining: Based on Original Area	Percentage Reduction in Area
6	1894	69.2	122.9	102	17.2
6	1894	60.2	136.2	113	17.2
6	1894	64.7	125.1	104	17.2
8	1894	64	125	109	12.9

Flow tests were made on all mains before and after lining and the following Table I shows the values of "C" in the Hazen-Williams formula based on original and final areas of the pipe section.

Cost data were kept and Table 2 shows the total cost of the lining to the district. The present estimated cost of new 8-in. cast-iron pipe installed is \$3.82 and 6-in. cast-iron pipe is \$3.10 per ft. Therefore, the cost of rehabilitating the mains in this area compares very favorably with the installation of new pipe.

The writers also agree with Mr. Rhodes that should further work of this nature be done by the East Bay Municipal Utility District, a saving could be effected by the use of different arrangements in doing the work.

TABLE 2

Cost Data for Lining 6-In. and 8-In. Cast-Iron Pipe in Oakland

Item	7762.6 Lin. Ft. 6-In. Pipe	3431 Lin. Ft. 8-In. Pipe
Contractor's Cost:		
Amount of bid	$ .811 per lin. ft.	$1.02 per lin. ft.
Man hours	1,456	1,033
Cost per man hour	$1.30	$1.43
Pipe cleaned and lined per man hour	6.33 lin. ft.	3.32 lin. ft.
Utility District's Costs:		
Preparatory work—back filling paving, etc.	$0.854 per lin. ft.	$1.67 per lin. ft.
Contractor's lining charge	0.811 per lin. ft.	1.02 per lin. ft.
Total	1.665	2.69
Total man hours	3,948	2,611
Cost per man hour, labor, equipment, material	$1.966	$2.19
Total Cost—District		
Labor	$4,717.37	$4,083.79
Equipment	723.09	608.05
Material	1,188.68	1,025.12
Total	6,629.14	5,716.96
Total Cost—Contract	6,297.49	3,489.42
Grand Total	$12,926.63	$9,206.38

C. W. Heinecke[3]

EL CENTRO is located in the heart of Imperial Valley, which has been for eons, a huge repository for the accumulation of chemicals leached from the vast watershed of the Colorado River basin. Since it lies below sea level and has no outlet, its soil and substratum carry a heavy chemical content.

The Colorado, which provides the life blood of this area, still carries a high content of salts and minerals. The action of the ground chemicals, together with those carried in the water, constitutes virtually a constant attack from without and within on cast-iron pipe. We believe that no area in the southwest is faced with a greater problem of a similar nature.

Experience has shown that the distribution of chemicals in the subsoil is not uniform and their action on pipe varies greatly in intensity within relatively small areas. This gives rise to the belief that an affinity, chemical combination, electrolytic action, or whatever it may be, causes greater

[3] Director of Public Works, El Centro, Calif.

damage where the super-mineralized soil is encountered. At such points the exterior of the pipe is encrusted with a thick, tough layer and there is a correspondingly thicker tubercular deposit inside the pipe.

In 1939 the whole distribution system of the city had become so obstructed by deposits that the service lines of smaller diameter were delivering less than one-fifth of their rated capacity. The system includes 180,000 lin.ft. of cast-iron pipe, ranging from 4 to 16 in. in diameter. Of this, more than 110,000 ft., or 60 per cent, were 4-in. pipe.

By experiment and investigation it was found that cement lining solved the problem of internal incrustation. A thorough survey of the system was made and a complete loop and grid system was installed. A rearrangement of two existing pressure towers was accomplished and, wherever necessary in the loop system, all small pipe was replaced by uniform-sized larger pipe which was cement-lined at the factory.

These replacements provided a supply of approximately 4 mi. of salvaged pipe of 4-, 6- and 8-in. diameters, all badly obstructed by incrustation averaging 1 in. thick. Many cases were found where the opening of a 4-in. pipe was restricted to less than the equivalent of 1-in. diameter.

A homemade power-driven spinning rack, built by city employees in the city shops, was used as a means of cleaning inside and outside as well as spinning the cement lining. The results obtained were very satisfactory. All of this rehabilitated pipe was used to replace badly obstructed lines. The cost of lining pipe in the manner just described is nominal, but the cost of removing and replacement, plus the cost of cutting and replacement of pavement solely for the purpose of lining, is very high.

Many experiments were made in the cleaning of pipes without removing them. This procedure is less expensive, simple and thorough so far as it goes, but in our case it was found to be futile, because once the interior of a pipe has been cleaned of tubercular formations, the action of building up a new layer on affected surfaces is rapid. In some cases the benefit derived from complete simple cleaning lasted but a few months.

The knowledge of the Tate Process —a method of applying cement lining underground—was obtained from a news article. The city was able to sign up a contract for lining approximately 4 mi. of 4-in. pipe.

The estimated time for completion was four months. It was done in six months.

Mr. Rhodes has presented a picture of the operation in a very accurate manner. Except in minor details, which are obviously occasioned by variance of conditions, there is nothing to add to or detract from his dissertation on this subject.

It can be suggested, however, that the City of San Diego has had the very decided advantage of more experienced operators and improved equipment inasmuch as the Tate Company had gained much valuable experience during the six months they spent in El Centro. This is a case of bread cast upon the waters, however, for we have entered a second contract for more than two miles, which we expect to start in the near future. We expect to benefit greatly by the added knowledge the contractors have acquired in San Diego.

It is notable that many objectionable

features we encountered during the progress of the work were wholly lacking or rendered innocuous in San Diego. For example, Mr. Rhodes inadvertently mentions the threading of sewer rods through the pipe in preparation for drawing cable through, and I quote ". . . with the aid of a small machine which rotates the rod." At the start of our job the Tate Company's crew made futile efforts to force by hand the old-fashioned wooden sewer rods through pipe which, in many places, was so effectively obstructed that it would have been difficult to force through a ¼-in. metal rod.

They did not know that the Flexible Sewer Rod Equipment Company's cleaning machine which, in our small town, is accepted as a fixture and a very necessary article, would do the trick. It required but one demonstration to convince the contractor that new methods can be found even in out of the way places.

Contract prices for the work in El Centro were identical with those in San Diego. The cost of the work performed by city forces appears to be approximately 60 per cent of that given by Mr. Rhodes, although the same work was performed for the same lining crew and equipment.

There is a wide variance in the figures covering increased flow of water as between San Diego and El Centro. The El Centro pipes were more completely obstructed. Fire hydrant flow tests taken at 11:00 P.M. on all rehabilitated lines showed from 100 per cent to 400 per cent increase after lining. An outstanding example is a hydrant located at the City Hall which showed a delivery of less than a hundred gallons per minute. This hydrant is located midway on a 4-in. line connecting a 6-in. line and a 14-in. line 1200-ft. apart. When the lining of this 4-in. pipe was completed the delivery at the same hydrant was increased to more than 400 gpm. The average flow at hydrants situated on the rehabilitated lines, before lining, was 135 gpm. After lining the average flow at these hydrants was 280 gpm. These high sounding figures may be readily analyzed when it can be shown that the incrustation in the 4-in. pipe averaged more than 1 in. in thickness and the waterway presented an extremely uneven surface built up of jagged pinnacles and stalactite formations.

It may be said with all frankness that the operation of underground lining presents many unpleasant features. It is very unpopular with the public because of the traffic interference. This was exaggerated in our case since we worked through our bad weather period. Nevertheless, the objective can be reached most economically by the Tate method and at a time when conservation of cast-iron, a material so vital in the war effort, is paramount.

During the progress of our work many things were accomplished which were not included in the contract, such as realignment, replacement and rearrangement of valves and other fittings. It was not unusual to find sections of pipe, at work openings, so badly deteriorated by graphitization that replacement was necessary. This fact leads to the conclusion that much of the pipe lined in place was undoubtedly unfit for rehabilitation in any other manner and that the application of the cement lining prolonged the use of this otherwise useless material.

A high light on the condition of the iron in our distribution system is evidenced by our experience with gate

valves. More than one hundred valves were uncovered and only two of this number were found suitable to be put back into service. The two valves used were of recent installation.

We are in full accord with Mr. Rhodes' views regarding the method of contract operations as used in our respective cities. Much duplication of effort and equipment, lost motion and conflict of authority, together with split responsibility, all increase the cost. This can be minimized if the contractor does all of the work or the city crew takes over the complete operation by agreement with the patent owners. In the dual handling of the work in the past, the city crew took the heavy end of the job. Under present labor shortage conditions this will be a vital point to consider. For this reason it is our determination, in future work, that speed will be sacrificed for economy and efficiency.

The object is to clean all lines to obtain full capacity, and to maintain them in this condition by means of cement lining. This objective has been reached in El Centro. The people are happy. The fire department is happy because the rehabilitation of our system has enabled them to put into use hydrants heretofore useless in the case of heavy fire-fighting equipment. The utilities, the ice companies, creameries, vegetable sheds where washing is a big item, have all abandoned their booster pumps and, for the time being at least, everyone is happy. The pipe lining feature is, therefore, important so far as the future is concerned.

A Medium Size City Puts on Its Thinking Cap

By C. J. Bruce

CUMBERLAND, Maryland, is a typical medium-sized city. The population is 40,000 and, including outlying areas dependent in part on its water supply, schools, streets, recreational and hospital facilities and industries, the overall population is approximately 50,000. Two nationally known industries have their headquarters there—the Celanese Corporation, currently employing 11,000, and the Kelly Springfield Tire Company, employing 2,500 people.

Everyone should recognize the importance of future planning, and exceptions to this rule are feckless and shiftless, be they persons or municipalities. Especially at this time the cities of the country are under pressure because of postwar employment problems. Out of the above mentioned population, Cumberland has 5,000 or 10 per cent in the armed services, a larger proportion than the country in general, and a sufficient number to constitute a grave problem in employment after the war.

Because of this problem the Mayor and City Council acted. In June, 1943, they established, by ordinance, a Municipal Planning and Zoning Commission for the City and provided funds for engineering assistance for the Commission.

Please note the makeup of this five-man Commission. The chairman is a practicing physician with long civic experience covering three decades in the governing body of the city and nearly twelve terms in the Mayor's chair. The secretary is the secretary of the Cumberland Chamber of Commerce, a wise choice on any planning commission, and the other three members of the Commission are the current Mayor of the city, a representative of labor unions, and the chief engineer of our largest industry.

The engineering firm finally selected and now working on Cumberland's problems, was that of Whitman, Requardt, and Smith of Baltimore. The following is the proposed outline of the report submitted by them to the Commission and is presented here as indicative of the items on which any city must have plans prepared—plus two additions which will be explained later.

A paper presented on October 15, 1943, in Philadelphia, at the joint meeting of the Four States Section and the Pennsylvania Water Works Operators Association; also at the West Va. Section Meeting in Parkesburg, on November 4, 1943, by C. J. Bruce, Supt., Evitts Creek Water Co., Cumberland, Md.

Following are the subjects covered:

I. Purpose of Report
II. History and Growth of Cumberland
III. Flood Control
IV. Water Supply
V. Sewerage
VI. Streets, Highways, Rail Crossings and Viaducts
VII. Public Buildings
VIII. Recreational Facilities
IX. Housing
X. Control of Area Beyond City Limits
XI. Zoning
XII. Building Code
XIII. Power and Utility Conduits
XIV. Municipal Finances
XV. Summary

Quoting from the report submitted by the engineers:

"It is our belief that the report which the Commission desires should be sufficiently comprehensive to enable not only the Commission, but the City Council, civic organizations, local citizens, federal and state agencies, as well as others, to have a clear picture of the existing systems which are described, in addition to a description of the proposed improvements. The report should be sufficiently complete and include necessary maps and diagrams so that little, if any, additional explanation is necessary to understand the recommended program. To accomplish these objectives, they would submit a report covering the various major subjects and subdivisions of major subjects outlined as follows:

I. Purpose of Report

The section of this report will be an introduction covering the instructions which have been issued by the Commission and the overall objectives which the report is to accomplish. It will include comments on city planning in general, the value of advanced planning for municipal construction, and the particular desirability of having at hand a program of postwar construction.

II. History and Growth of Cumberland

A. Narrative History

Early history
C. & O. Canal
Railroads
National prominence in relation to County, State and Nation

B. Present Status

Industry
Railroads
Commerce
Residential development

C. Population Trends

Census records
Characteristics of population
Predicted future growth
Population curve
Development of Cumberland in relation to surrounding area

D. Outlook for the Future

Industry
Population growth
Development of Potomac River Basin

III. Flood Control

A. Description of Locality

Topography of Potomac River Valley
Topography of Wills Creek Valley
Susceptibility to floods

B. History of Floods

Major floods and frequency of flood stages
Past flood damage

C. Previous Flood Control Studies and Reports

U.S. Engineer Dept.—Plans by Major Luplow and Colonel Thomas
Special consultants to City—Plan by Kimball
Other studies and reports

Interstate Commission on Potomac River Basin
Upper Potomac River Board

D. State and Federal Participation in Flood Control Construction

Federal aid
Assistance from State and Interstate Commissions
Obligations of the City of Cumberland

E. Recommendations

Recommended program of flood control construction
Relation of program to other municipal improvements
Probable participation by other agencies

F. Estimate of Cost and Economic Justification

G. Maps and Diagrams

IV. Water Supply

A. Existing System

History and growth of system
Description and capacity of present works
Industrial, commercial and domestic water consumption
Brief review of water finances

B. Present and Estimated Future Water Consumption

Adequacy of present works
Estimate of future needs, domestic, industrial and commercial
Curves and diagrams

C. Recommendations

Source of supply
Treatment plant
Transmission and distribution mains
Storage reservoirs
Miscellaneous

D. Estimates of Cost

E. Maps and Diagrams

V. Sewerage

A. Existing Systems

History and growth of system
Description of present system of sewers
Capacity of present system
Industrial waste

B. Present and Estimated Future Sewage Flows

Present flows—sanitary and combined
Estimated future flows
Curves and diagrams

C. Recommendations

Collection system
Interceptors and outfall
Sewage treatment plant
Pumping stations required by flood control program

D. Estimates of Cost

E. Maps and Diagrams

VI. Streets and Highways

A. Existing Facilities

Description and growth of streets and highways
Status of paving
Location and description of bridges and RR crossing structures

B. Previous Studies and Recommendations

Bridges and viaducts
Underpasses and overpasses
Traffic studies and related highway studies

C. Present Status and Future Needs

Relation of city to state and federal highway programs
Present hazards and bottlenecks
Parking

D. Recommendations

Viaducts, bridges, underpasses and overpasses
New highways
Parking
Suburban development

E. Estimates of Cost

F. Maps and Diagrams

VII. Public Buildings

A. Existing Facilities
List of city-owned buildings
Use and capacity of same

B. Recommendations

General recommendations on utilization of existing buildings, and possible future building construction

VIII. Recreational Facilities

A. Existing Facilities

Description of parks and present recreational areas

B. Recommendations

Adequacy of present facilities for present and future needs
Colored recreational areas

IX. Housing

A. Present Housing Development

General description of housing in the city
Housing trends
Urban and suburban housing

B. Recommendations

Steps to be taken in anticipation of future housing problems

X. Control of Areas Beyond City Limits

A. Description of Metropolitan Area

General history and growth of subdivisions
Relation of subdivisions to city streets, sewer and water

B. Recommendations

Trends of probable future growth
Necessity of control of subdivision layouts
Experience of other cities in control of subdivisions
Legislative action to obtain necessary control

XI. Zoning

A. Existing Conditions

Degree of control exercised
General description of industrial, commercial and residential developments

B. Proposed Zoning Plans and Ordinances

C. Recommendations

General recommendations on steps to be taken in anticipation of future housing problems, and their effect on zoning problems

XII. Building Code

A. Existing Code

Brief description of existing building code

B. Recommendations

General, not specific, discussion of adequacy of present code
Suggestions for change and modifications

XIII. Power and Utility Conduits

A. Existing Conditions

Description of location and arrangements of existing conduits

B. Recommendations

General recommendations on type of construction and description of areas for such future construction

XIV. Municipal Finances

A. Financial Statements

Tax rates, income, property valuation and assessments, status of bond issues for previous five years

B. Comments

General comments on financial status of the city and ability to carry out various recommended improvement programs

XV. Summary

A. Tabulation of Foregoing Recommendations and Estimates of Cost

B. Comments

Engineering comments on the needs of the city, prepared in a manner to assist the Commission in establishing a program of construction and priorities of the various items to be done

"Each of the above major subjects and sub-headings will be discussed in as much detail as is consistent with the importance of the work to be done. Maps and diagrams will be included to show graphically the work that is recommended. It is to be understood that the outline is preliminary and subject to modification which may prove desirable as the detailed studies are undertaken.

"To collect the essential information which should be at hand as a basis of the studies, designs and engineer-

ing recommendations, it will be necessary for competent engineers of the firm to interview the members of the Commission and city officials at considerable length, as well as obtain additional data from local utilities, power plants, industries, railroads and other local bodies. It will require careful review of existing information now in the hands of Army Engineers and other agencies and commissions responsible for the development of the Potomac River Basin. In addition to the collection of data from local agencies and industries, it will be necessary for your city engineer to supply maps and information needed to prepare such diagrams as are needed for incorporation in this report, and we bespeak his co-operation. Field work by survey parties will be at a minimum, but it is expected that some work of this nature may be necessary, the extent of which can be determined after a more detailed review of existing records. Following the compilation of basic information, careful studies by various specialists in our organization will be necessary, along with sufficient basic designs to permit the preparation of preliminary estimates of cost."

There are two outstanding omissions in the engineering report which are items of great importance to any city—schools and airports.

In Maryland, schools are operated under control of the State and county, and do not fall within the province of the city; hence the omission.

In the matter of the airport, I think any city should include that item in its planning. Cumberland Airport is nearly completed and, therefore, was left out of the planning program, but airports will certainly be integral parts of civic economics in the years to come, and their growth should be charted as far as is possible in advance. LaGuardia Field in New York, which was outgrown before it was completed, and the Baltimore City Airport, which has always been too small, are cases in point. No one today can see a Flying Fortress land at what was once considered a first-class air field without a rise in blood pressure. Airfield engineering will be one of the many problems in the post-war world.

One possible and hoped for result of planned projects is a change in the psychology of the employed. WPA left some excellent results in roads, bridges and public works, but the effect on the self respect of thousands of workers was definitely bad. The difference in the workers' attitude was shown plainly in the actions of the men employed building a road that had to be finished at no definite time, and the same shovel leaners repairing a washout on a traveled road or cleaning up the ravages of a flood. When there was something vital to be done, they worked briskly. Otherwise the loafers were numerous. If we plan and blueprint now for necessary and worthwhile works and make boondoggling unnecessary, we will do the American people a valuable service.

Transmission of Virus Diseases by Water

By E. R. Krumbiegel

IT has been well established, on the basis of adequate laboratory and epidemiological evidence, that water has served as the vehicle for spread of the infectious agents of a rather large number of specific diseases. Water generally becomes dangerous to man because it has been polluted with pathogenic organisms from human sources. Communicable diseases commonly known to be spread by water are usually those in which the etiologic agent enters the body via the gastro-intestinal tract and leaves in the feces or urine, or both. Egress from the body in this fashion frequently permits the causative agent to find its way into water supplies used for human consumption. Epidemics have occurred frequently due to such polluted supplies because facilities for adequate water purification were not available, or because laxity resulted in failure to exert adequate vigilance over available purification procedures.

Recently, attention has again focused on the possibility of transmission of virus diseases of man by water. To date, two viruses have been isolated from human stools, namely those of foot and mouth disease (1) and poliomyelitis (2–5). It is interesting that both of these viruses are extremely minute and are among the very smallest of the viruses known to be pathogenic for man. The epidemiology of foot and mouth disease is rather well understood. There is no evidence to show that it is ever transmitted to man by water and it need not be considered because it has appeared in the United States on only a few occasions and fortunately has been effectively suppressed.

Poliomyelitis is an important communicable disease in most parts of the U.S. and some investigators have suggested the possibility of its epidemic spread by water. The usual human portal of entry of poliomyelitis virus cannot as yet be said to be clearly established. There is, however, an accumulated weight of evidence which points toward the gastro-intestinal tract as the probable portal (6–11). An increasing number of investigators are leaning toward the belief that although poliomyelitis is essentially a disease affecting the central nervous system, it may be a "digestive tract disease" in that the virus may enter the body through one end of the tract and leave by way of the opposite end.

Poliomyelitis virus has been found repeatedly in the stools of patients during the second or third week of convalescenc following paralytic or recognized abortive attacks. It has also been

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demonstrated in the stools of persons with illness of indefinite character or with no clinical evidence of illness. The presence of virus in the stool may persist for several weeks and has been reported (4) to persist in the stool for as long as 123 days following a mild attack of the disease. It has been estimated (12) that 50 gm. of stool may contain from 1,000 up to 10,000 doses of virus infective for monkeys.

Poliomyelitis virus is exceedingly stable. It has been shown to survive in 50 per cent glycerol for as long as 8 yr. (13). It withstands low dilutions of phenol and 15 per cent ether, both of which are inimical to preservation of the viability of bacteria. It is not surprising then that the presence of the virus should occasionally be demonstrated in sewage. Tests have shown (14–15) that fairly large quantities may be present in sewage during epidemic periods or periods of peak incidence, although most positive results have been obtained in the vicinity of hospitals. The presence of poliomyelitis virus in sewage may seem to be a dangerous thing from an epidemiologic viewpoint. Actually, its presence there is not necessarily of epidemiologic significance, any more than the presence of the tubercle bacillus in sewage is indicative of sewage being of any importance in the spread of tuberculosis.

Water Supply Contamination

The fact that poliomyelitis virus has been demonstrated in sewage is of significance to water works officials because sewage is frequently disposed of by transferring it to surface waters in such a manner that contamination of drinking water supplies may result. It is, therefore, desirable to inquire into the effect that modern sewage disposal operations and water purification methods have upon the virus.

Sewage Treatment

At present the literature contains only one report dealing with the effect of sewage treatment on poliomyelitis virus. Carlson, Ridenour and McKhann (16) recently reported upon the effect of the activated sludge process, as used in municipal sewage disposal plants, in removal or inactivation of a mouse adapted strain of poliomyelitis virus. A virus suspension of 1 : 300 was used in sludge concentrations of 1100, 2200 and 3300 ppm., the aeration periods being 0, 6 and 9 hr. It is to be emphasized that the virus suspension used was 1 : 300 which is an extremely heavy inoculum, far greater than would ever conceivably be the case in a sewage treatment plant.

While their results are not as easy of exact interpretation as is desirable, they do indicate that activated sludge in amounts as low as 1100 ppm. with 6 hr. aeration, inactivated or removed the virus sufficiently to prevent or very greatly reduce infectivity for intracerebrally inoculated mice. The method by which the virus is removed or destroyed is not clear. It may be due to absorption on sludge particles, precipitation by aeration, or to enzymatic, oxidative, or other viricidal action of the activated sludge. It is gratifying to know that the activated sludge method of sewage treatment is effective in the removal or destruction of at least one pathogenic virus in addition to numerous pathogenic bacteria.

The effect of water purification methods on poliomyelitis virus has not been adequately investigated. In sterile water kept at room temperature in the dark, the virus has been found to remain active for as long as 114 days

(17) and it also withstands freezing (18). Carlson, Ridenour and McKhann (19) have investigated the effect of certain methods, commonly employed in water purification plants, on the removal of poliomyelitis virus from artificially contaminated water. They used a virus strain adapted to mice; the dilution usually used being 1 : 500. It is to be emphasized that the water used was exceedingly heavily contaminated with virus. While their results cannot be regarded as conclusive, coagulation and sedimentation seemed to produce a slight reduction in the total amount of virus in any suspension, the reduction being proportional to the amount of virus present. Sand filtration alone apparently held back very little of the virus. When, however, large amounts of alum floc were permitted to impregnate the surface layers of the filter, so the rate of flow was reduced from 144 ml. per minute to 102 ml. per minute, filtration apparently very greatly reduced the amount of virus. The addition of activated charcoal in concentrations of 10, 25 and 50 ppm. was partly effective in removing the virus by absorption.

Chlorination Studies

The effect of chlorination on inactivation of the virus in water has been studied by several investigators. It is claimed as mentioned by Armstrong (20) that artificially-contaminated, slightly turbid water was rendered noninfectious after 24 hr. by 4 ppm. of chlorine while 0.4 ppm. sufficed in clear water. A 1 : 1650 suspension of virus treated with 0.5 ppm. of chlorine was not inactivated in $1\frac{1}{2}$ hr. but was in 4 hr. A concentration of 1.5 ppm. of chlorine in tap water inactivated the virus in 20 min. and a concentration of 0.55 ppm. after 1 hr.

It must be emphasized that these experiments dealing with the effect of water treatment methods on poliomyelitis virus are inconclusive because relatively high concentrations of virus were employed and the treatment methods were tested individually. They tell us little about what water purification methods would do if the virus were present in small concentration and if treatment methods were used in the sequence ordinarily employed in dealing with surface water supplies.

It is evident that, on the basis of certain laboratory experiments, a hypothesis that poliomyelitis epidemics may be water-borne can be built up. Before any such hypothesis can have any true meaning or acceptance, however, it must be in accord with the known epidemiology of the disease. To date, epidemiological evidence fails to indicate that water is biologically of any importance as a medium of transmission of poliomyelitis virus. Before water can be considered of any practical importance in the spread of poliomyelitis it would be necessary to show that the behavior of the disease in some places or at some times is dependent upon contaminated water. This has never been done and its known epidemiological behavior is definitely not compatible with a water-borne theory of spread.

In the north temperate zone, poliomyelitis epidemics occur during the summer and early autumn weeks. Cases occur only sporadically and rarely during the winter and spring months. Since cold exerts no deleterious influence on the virus there is no logical reason why, if poliomyelitis is spread by water, epidemics should not commonly occur during the winter or spring. The seasonal incidence of the disease is, therefore, not in accord-

ance with a water-borne theory of spread. When poliomyelitis is epidemic in a community it is also usually epidemic in numerous other communities within a radius of several hundred miles, irrespective of their sources of water supply. This condition is not seen with true water-borne epidemics of typhoid fever or dysentery.

Epidemics of acute water-borne diseases occurring in large communities are characterized by explosive onset with cases occurring in large numbers practically simultaneously in all parts of the community. If poliomyelitis were water-borne an extremely sharp epidemic onset would be expected. Actually, epidemics of this disease begin insidiously and usually extend over a period of 6 to 10 weeks, ending abruptly with the onset of relatively cold weather. If poliomyeylitis were spread by drinking water one would expect widely different case rates in adjoining communities utilizing different water supplies and as yet this has not been shown to occur.

The prevalence of the disease has not been correlated with the degree of sanitary care surrounding different water supplies as determined either by bacteriological examination or sanitary survey. If one is to assume that ordinary water purification methods are ineffective in removing the virus, then one must expect the highest incidence of the disease among cities obtaining their water supplies from rivers heavily polluted with sewage. Actually, the incidence of poliomyelitis has not been abnormally high in such cities. Comparably, one would expect cities receiving water supplies from sources carefully protected from pollution by human feces to be free from epidemics, and yet such communities have repeatedly suffered from sharp outbreaks. In rural areas poliomyelitis spreads at a relatively constant pace from area to area in a totally unpredictable manner which bears no relationship to the character of water supplies.

It is thus apparent that although a theory of water-borne spread for poliomyelitis can be hypothecated, such a theory is not in accordance with the known biologic behavior of spread of the disease, which is distinctly different from that of other diseases sometimes known to be water-borne. There is at present no epidemiological evidence that permits the belief that water is of any importance in the spread of poliomyelitis.

References

1. Kling, C., Huss, R. & Olin, G. Presence de la Fievre Aphtheuse dans el Contenu Intestinal d'un Suject Humain Vivant dan un Milieu Infecte. Compt. Rend. Soc. de Biol. (Fr.), **131**: 478 (1939).
2. Harmon, P. H. The Use of Chemicals as Nasal Sprays in the Prophylaxis of Poliomyelitis in Man. J. Am. Med. Assn., **109**: 1061 (1937).
3. Howe, H. A. & Bodian, D. Untreated Human Stools as a Source of Poliomyelitis Virus. J. Infect. Dis., **66**: 198 (1940).
4. Lepine, P., Sedallian, P. & Sautter, V. Sur la Presence du Virus Poliomyélitique dans les Matières Fécales et sa Longue Duree d'Elimination Chez un Porteur Sain. Bul. Acad. de Med., (Fr.) **122**: 141 (1939).
5. Trask, J. D., Vignec, A. J. & Paul, J. R. Isolation of Poliomyelitis Virus From Human Stools. Proc. Soc. Exptl. Biol. & Med., **38**: 147 (1938).
6. Toomey, J. A. Active and Passive Immunity and Portal of Entry in Poliomyelitis. J. Am. Med. Assn., **109**: 402 (1937).
7. Vignec, A. J., Paul, J. R. & Trask, J. D. Poliomyelitis Virus From Feces in Non-Paralytic Poliomyelitis. II. Infectivity by Various Routes. Proc. Soc. Exptl. Biol. & Med., **41**: 246 (1939).

8. Burnet, F. M., Jackson, A. V. & Robertson, E. G. Poliomyeltis—The Use of Macacus Cynomologus as an Experimental Animal. Australian J. Exptl. Biol. & Med. Sci., **17**: 375 (1939).

9. Trask, J. D. & Paul, J. R. Experimental Poliomyelitis in Cercoptheus Aethiop Sabaeus (the Green African Monkey) by Oral and Other Routes. J. Exptl. Med., **73**: 453 (1941).

10. Howe, H. A. & Bodian, D. Portals of Entry of Poliomyelitis Virus in the Chimpanzee. Proc. Soc. Exptl. Biol. & Med., **43**: 718 (1940).

11. Faber, H. K. & Silberberg, R. J. Pathway of Invasion in a Cynomolgus Monkey After Oral Application of Poliomyelitis Virus. Science, **96**: 473 (1942).

12. Paul, J. R. & Trask, J. D. Occurrence and Recovery of the Virus of Infantile Paralysis From Sewage. Am. J. Pub. Health, **32**: 235 (1942).

13. Rhoads, C. P. Survival of the Virus of Poliomyelitis for Eight Years in Glycerol. J. Exptl. Med., **49**: 701 (1929).

14. Paul, J. R., Trask, J. D. & Gard, S. Poliomyelitis Virus in Urban Sewage. J. Exptl. Med., **71**: 765 (1940).

15. Paul, J. R. & Trask, J. D. The Virus of Poliomyelitis in Stools and Sewage. J. Am. Med. Assn., **116**: 493 (1941).

16. Carlson, H. J., Ridenour, G. M. & McKhann, C. F. Effect of Activated Sludge Process of Sewage Treatment on Poliomyelitis Virus. Am. J. Pub. Health, **33**: 1083 (1943).

17. Kling, C., Levaditi, C. & Lepine, P. La Penetration du Virus Poliomyélitique à Travers la Muqueuse du Tube Digestif Chez le Singe et sa Conversation dans l'Eau. Bul. Acad. de Med. (Fr.), 3 Série Vol. **102**: 158 (1929).

18. Kramer, S. D., Grossman, L. H. & Hoskwith, B. Active Immunization Against Poliomyelitis. A Comparative Study. J. Immunol., **31**: 199 (1936).

19. Carlson, H. J., Ridenour, G. M. & McKhann, C. F. Efficacy of Standard Purification Methods in Removing Poliomyelitis Virus From Water. Am. J. Pub. Health, **32**: 1256 (1942).

20. Armstrong, C. Infantile Paralysis 1941, The Natl. Found. for Infantile Paralysis, Inc., p. 40.

The Significance of Good Employee-Employer Relationships

By Edward B. Mayer

THE fundamental principles of good employee-employer relations have not changed since the days of decentralized industry; only the application of these principles has changed to keep pace with accelerated business and living conditions. The tempo of modern living was gradually quickened by employers whose foresight and genius for organization, coupled with their ability to make money, enabled them to create, expand and maintain large corporations. Some of these men, from the very beginning, realized that one of the most important single factors for the success of an organization is freedom from labor difficulties. Others—and unfortunately these were in the majority—either failed to appreciate the value of a congenial labor-capital relationship (which, reduced to its common denominator simply means good employee-employer relations) or chose to ignore it. These are the unscrupulous men who exploited their workers in order to satisfy their own greed for monopolistic control of industry and the accumulation of vast sums of money for themselves and their stockholders. Therein lies the responsibility for the creation of workers' unions. These are the men responsible for the chaotic labor conditions that exist throughout the nation today.

When abused workers banded together to form embryonic labor unions, they were impelled so to do by a very real necessity for better working conditions, shorter working hours, more pay, etc. Their leaders were men from within their own ranks who suffered from the same conditions, who were actually representative of their groups, and who, because they dealt directly with their own employers, were reasonable in their demands. Too many employers either refused to negotiate with their employees' representatives or, if they did receive them, failed to live up to the terms of their bargains. The golden opportunity to establish a sound foundation for good employee-employer relations—arbitration within corporations—was lost. Men, as unscrupulous as the adamant corporation heads, saw in this impasse the opportunity to coerce both capital and labor, seized control of the bargaining agencies from their rightful leaders, the employees, and set up the machinery which created the labor unions of today.

Protection Against Exploitation

We all recognize that there is a definite need for control of both labor and industry; that the working man needs

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and has a right to protection against exploitation; that industry needs and is entitled to protection against disruption of its activities through strikes and slow-downs. Some believe that complete unionization is the answer; others, that the abolition of unions and the adoption of federal labor laws will provide the solution to this knotty problem. Between these two are those who believe that the enforcement of basic federal labor laws dealing with minimum and maximum wages, productive working hours, and healthful working conditions, plus the establishment of good, workable intra-corporation employee-employer relations, accomplished through co-operative conferences between corporation heads and the organized employees' association representatives, will bring about the desired and necessary amity between labor and industry.

While they do have their operational defects, large public utilities and governmental agencies have proved the value of the last cited theory.

I am personally affiliated with a large municipal utility whose administrative office doors are always open to the employees, and I have seen employees come to these offices for counsel on all types of problems—personal and otherwise. Gradually, this friendly co-operation between the management and its employees has grown until policies dealing with personnel problems now are discussed in round-table conferences with representatives of the Employees' Association. Recently, following the prevailing practice of other large corporations, an Employee Relations Director has been added to the staff to serve as an impartial expert in the field of personnel relations. That this spirit of sympathetic and friendly understanding on the part of the management has paid dividends in the form of employee confidence and loyalty is attested by the fact that although we are a $200,000,000 utility, with a large personnel, we have been singularly free from labor difficulties.

Employee Benefits

Not the least of the reasons for the good employee-employer relationship which exists in our organization is that our employees know, that once having completed their six-months probationary periods (during which time they are closely observed and if found unsatisfactory are subject to instant dismissal), they are permanent employees, removable only for cause and eligible to enjoy all the benefits of secure positions with a large modern utility—fixed salaries with provision for overtime pay, set hours of work, assigned working locations, annual two-week vacations with pay, specified opportunities for promotion and salary increases, protective leaves of absence for various sound reasons, etc. Employees are free from political influences and there are no restrictions against race, color, creed or membership in any organization that is non-political. Moreover, as a reward for faithful service, the management has fostered the following welfare program:

1. A Retirement, Disability and Death Benefit Plan with both the employee and the employer contributing equal shares to the fund

2. Periodic physical examinations of employees by the medical staff in a successful attempt to prevent long disabilities; and, along these lines, the maintenance of rest rooms for men and women, with a doctor or a registered nurse in constant attendance

3. A cafeteria where wholesome hot meals, light lunches and refreshments

are served at cost amidst pleasant surroundings

4. A Credit Union where employees may invest savings, purchase War Bonds or borrow money

5. An Employees' Association which provides recreational activities, membership in a low-cost medical clinic and group life insurance

6. A corporation magazine, published monthly, written simply, which deals with matters of interest to the employees such as the progress of various maintenance and construction projects, taxation, changing labor laws, governmental rules and regulations, sports items and personal glimpses of fellow employees

7. A transportation and rationing committee which handles employee problems relative to gas rationing, share-the-ride transportation, safety shoes, etc.

The corporation is contemplating an educational program embracing the arts and sciences as well as subjects relating directly to business activities; and is also planning the distribution of a daily, semi-weekly or weekly bulletin apprising all employees informally of current events important to the conduct of business or to employee morale.

In citing our organization as an example of what may be accomplished through co-operative conferences and the establishment of equitable regulations governing wages and working conditions, I am fully aware of the fact that we are reaping the benefits of a large invested capital and a big organization. I am cognizant of the fact that free-lancing professional men and employees of small firms lack the protection against exploitation that even loosely organized groups secure as a matter of course.

Professional Groups and Personnel

That professional groups are beginning to awaken to the need for sound personnel programs is attested by the fact that at the National Convention of the American Society of Civil Engineers held at the Biltmore Hotel in Los Angeles in June of this year, Past-President Black touched upon the subject when he asserted that the Society, having admirably devoted all of its time and energy to scientific exploration and development, nevertheless has paid too little attention to establishing standard wages, fees and working conditions for its engineers in private industry. He pointed out that this lack of attention to a very real problem of the engineering profession has been forcibly impressed upon the minds (and the pocketbooks) of Society members by present war conditions; for many engineers, working on government contracts which made no provisions for overtime pay, found themselves receiving less than some of the day-laborers they employed.

To make matters worse, the government established the War Labor Board which provides employee-employer representation for purposes of arbitration in wage and salary and working condition disputes involving all types of employees other than professional men. As a result, many engineers aligned themselves with either the AFL or the CIO. They and other members of the profession realize, however, that this is not the solution to the problem. In order to maintain the high ethical standards set by the A.S.C.E. without jeopardizing the privilege of professional men to establish their own fees, I believe that it will be necessary for engineers to refrain from identifying themselves with any and all out-

side labor unions and to reorganize the parent organization to act as a so-called bargaining agency, appointing an authoritative board of arbitration to represent its members in all wage and salary and working condition disputes.

These plans are applicable also to the American Water Works Association and it behooves each member to do some constructive thinking along these lines right now. Active participation in the personnel field would not lower the dignity of the Association nor its ethical standards but would materially increase its usefulness in the water works field.

Job Standards

Labor unions have already set up job standards with corresponding salary schedules and I believe that we all recognize the worth of these efforts. If the engineering profession desires to retain its right to supervise all engineering activities, however, it must combat the control of labor organizations over management in those personnel matters pertinent to its members. To accomplish this it must set up its own job standards, based upon the ethical standards it has developed over the years. This will form a basis for a sound salary policy applicable to the engineering profession.

Conclusions

Maintaining good employee relations as a part of management is a science in itself. You may wonder what "science" has to do with personnel management. If we analyze the word "science" we find that it means nothing more nor less than the application of co-ordinated, codified knowledge which has been gained by systematic observation, practical experimentation and logical reasoning. Therefore, I maintain that personnel management is a science and should be so regarded by the A.S.C.E., the A.W.W.A., labor leaders and all executives of modern business.

It is impossible to touch on all points of so important a subject as the establishment and maintenance of good employee-employer relations in so brief a paper as this one, or even to draw a definite conclusion, for what may be governing factors today may not hold true tomorrow. However, I should like to stress the fact that amicable employee-employer relations, with resultant high levels of efficiency, have proved their worth in large public utilities and government agencies over a period of years and, more recently, in private business. The methods used to establish and maintain good employee-employer relationships will naturally vary from one corporation to another but in all cases it is important that co-operative conferences be attended frequently by corporation heads and representatives of the employees.

Whatever the method used, in every plant co-operative conferences should be organized at the earliest possible moment to scrutinize the desirability and the applicability of various proposals, to initiate selected plans experimentally, and thus to prepare a modern, smooth pattern of good employee-employer relations against the day when this war will be ended and millions of men, released from the armed forces, will have to be absorbed into industry with the least possible disruption of plant and personnel activities at wages which will be commensurate not only with the individual's duties and qualifications but with the then-current cost of living.

Reconditioning of Warped Meter Discs

By George C. Sopp

THROUGHOUT the water works field there has been a considerable amount of time spent in study and research in developing the water meter to its present-day standard of refinement and efficiency. Its durability and high registration accuracy over long periods of service under varied operating conditions are most outstanding in the field of measuring devices. Many individual water works men, as well as meter manufacturing companies, have contributed toward the development of the present-day water meter with its high standard of efficiency.

Practically from the time of its inception the American Water Works Association has been vitally interested in problems concerning the water meter, and as a result of continuous studies has recently prepared and adopted new and improved standard specifications for cold water meters which unquestionably will raise the general standard of performance for all water meters produced in the future. Several makes of meters have already reflected improvements which will redound to the benefit of the water works industry.

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One needed improvement, however, which long has been under consideration and for which a satisfactory and permanent solution has not yet been found, is the elimination of the distortion or warping of hard rubber water meter discs ordinarily caused by hot water or steam backing up through the meter from defective water heating devices. These distorted or warped water meter discs are commonly known as "burned" discs.

Many attempts have been made to produce discs of various compounds that would be heat-resistant and therefore not subject to distortion. These attempts have met with varied degrees of success, but to my knowledge no disc has yet been produced to embody all the necessary qualities of the present-day hard rubber disc and still have the desired quality of being heat-resistant. Many types of plastic materials have been molded into meter discs, some of which have been found to resist heat satisfactorily; yet, the water absorption of these materials is much higher than that of the hard rubber disc, rendering the plastic disc generally undesirable.

An ideal material for water meter discs should embrace at least the following specifications:

1. The material should be tough, very durable, and practically non-disintegrating in water.

2. It should be slightly flexible and capable of receiving and maintaining a polished surface.
3. It must be non-corrosive and should not induce corrosion when in contact with bronze measuring chambers.
4. Its specific gravity should be near that of water to avoid undue wear of the bearing surfaces and to reduce friction loss to a minimum.
5. It should be non-absorbent in water under constant normal pressures.
6. It should be *heat-resistant.*

Inasmuch as the ideal meter disc has not yet been produced, water meter repair shops throughout the country are still faced with the problem of having to discard burned and sprung meter discs. The Bureau of Water Works and Supply of the City of Los Angeles has faced this problem for many years and has been constantly working toward a satisfactory solution in an attempt to reduce the cost of meter repairs where the discs have been burned or warped out of alignment, which made it necessary to discard the old discs and replace them with new discs to maintain the registration accuracy required.

With a total of 316,837 water meters in service in the distribution system of the Bureau, as of October 1, 1943, the cost of replacing burned and sprung meter discs is still a big item in the average unit cost of our meter repairs, even in view of the fact that new and greatly improved domestic and commercial hot water systems have been installed, which have gradually decreased the annual number of such damaged discs.

During the last seven years, the average number of meter discs replaced annually, due to these causes, was 3,554. Of the average yearly number of disc meters repaired in sizes from $\frac{5}{8}$ in. to 2 in. inclusive during the same period, approximately one out of every four required replacement of a disc which had been burned or sprung.

With the average cost of new discs ranging from $1.33 to $10.86 each, in sizes from $\frac{5}{8}$ in. to 2 in. inclusive, a comparative idea can be had of the cost involved in these replacements.

How Do Meter Discs Become Burned or Sprung

When a hard rubber disc is fitted into a measuring chamber of a $\frac{5}{8}$ in. or $\frac{3}{4}$ in. water meter, approximately 0.010 in. clearance is allowed between the periphery of the disc and the wall of the measuring chamber. Slightly increased clearances are necessary for discs in meters of larger sizes. This close fit between the disc and the wall of the measuring chamber is necessary to preclude the passing of water from the upper to the lower side of the disc or vice versa. However, this clearance is essential in order to reduce to a minimum the friction between the periphery of the meter disc and the wall of the measuring chamber, thereby making possible a high degree of sensitivity. If for some reason the hard rubber disc becomes enlarged, the clearance between the disc and the wall of the measuring chamber diminishes, thus causing increased friction. If the disc continues to enlarge, friction with the wall of the measuring chamber increases and the disc binds on the wall of the measuring chamber and becomes immovable, thereby blocking the normal flow of the water through the measuring chamber of the meter. Where the temperature of the water is normal and a blocking of the waterway occurs due to the disc becoming immovable

within the measuring chamber for reasons other than swelling, extremely high loss of head develops and the amount of water discharged is materially affected. Under these conditions a disc may either break or become sprung if the pressure differential is too great for the disc to withstand.

Where the hard rubber disc is subjected to water temperatures of approximately 150°F. or above, it not only tends to enlarge and bind in the measuring chamber but it also becomes semi-plastic and thereby loses its normal rigidity. With the disc enlarged and binding on the wall of the measuring chamber, and at the same time having been reduced to a semi-plastic state, it is vulnerable to inoperative distortion caused by the hot water or steam creating a temporary excess pressure condition in the plumbing, which reverses the normal direction of flow through the meter, causing the disc to twist out of alignment; or by water being drawn from the plumbing while the disc is in a semi-plastic condition which would likewise cause the disc to force itself out of alignment in attempting to operate. If the disc has been forced out of shape and the heat has been dissipated and water temperature restored to normal, the disc hardens in its distorted shape. A water meter disc in this condition is said to be warped or "burned."

Inasmuch as the disc has an extremely small clearance on the top and bottom, as well as around its periphery when in the measuring chamber, it cannot operate when so distorted. To all intents and purposes these burned discs have been rendered useless, and the general practice of water meter repair shops has been to discard these seemingly useless discs and replace them with new units.

We have found that by properly heating and remolding these discs they can be used again in a water meter with no apparent decrease in the operating efficiency of the meter.

Developing the Remolding Process

Early in 1941, experimentation was begun in our meter shop to determine definitely the possibility of remolding and straightening burned and sprung discs in an attempt to effect a saving in meter repair costs. Difficulties were encountered in the early stages of our experiments, such as determining the correct shape and thickness of molding dies, material from which the dies should be made, clearance necessary for the controlling of expansion and contraction during remolding to produce a disc of the desired size, and the proper heating of the damaged disc while in the process of treatment.

By January 1943, our experiments had been completed, and the remolding and straightening process was established by the Bureau as a regular meter repair procedure. All burned and sprung water meter discs, both flat and conical types, are now reconditioned in our Water Meter Shop at a saving of 81 per cent to 93 per cent of the cost of new meter discs.

Remolding Process

Burned and sprung meter discs of the flat type are processed satisfactorily, without removing the disc spindle and the two half-balls, on all discs of sizes smaller than 1½ in. Discs in sizes 1½ in. and larger are stripped of their disc spindles and half-balls, as a better perpendicular alignment of the spindle to the disc can be had by working with the disc alone in these larger sizes.

In the case of the conical type disc, which usually is made in one piece with the disc spindle inserted through the center of the ball, it is processed as a complete unit irrespective of size. The conical type disc is found to respond to the reconditioning process more readily than the flat type, due primarily to the metal reinforcement within the body of the disc being somewhat under tension while the disc is in a burned or sprung condition, which tends to aid

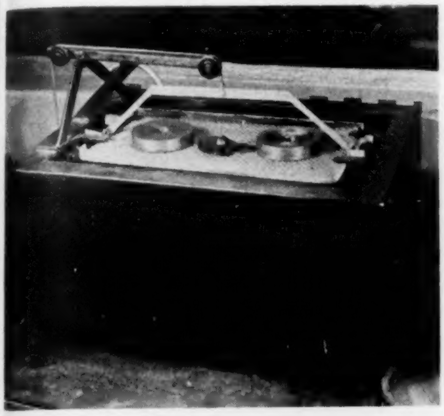

FIG. 1. Heating Vat, Showing Movable Tray With Molding Die and a Distorted Disc

the straightening process when the disc is heated and remolded.

The proper type and correct size of mold is selected and, together with the disc to be reconditioned, is placed on the heating tray and lowered into the heating vat containing water at 212°F. The mold is heated along with the disc in order that the mold shall be at the same temperature as that of the disc during the actual remolding process, thereby eliminating the possible pre-cooling of the surface of the disc which could occur if the mold was allowed to be at room temperature.

Heating the Discs

From tests and analyses made on discs which have been processed, we find that there is no appreciable deterioration of the composition or strength of a disc which has been allowed to stand in water at 212°F. for a matter of hours, but inasmuch as the heating of the disc is merely a means of reducing it to a semi-plastic state, the minimum time necessary to produce this effect is the most economical. In the case of $\frac{5}{8}$ in. and $\frac{3}{4}$ in. discs, the time required to heat the discs properly is from $2\frac{1}{2}$ to 3 min.; 1 in. approximately 6 min.; $1\frac{1}{2}$ in. approximately 12 min.; and 2 in. approximately 15 min.

The disc is heated in the bottom half of the mold; otherwise the heated and expanded disc is difficult to press into the mold, and in some cases it may even be impossible to press it into the mold without permanently injuring the smooth periphery of the disc. With the disc pressed into the bottom half of the mold (and in the case of the $1\frac{1}{2}$ in. and 2 in. discs, as well as for some makes in smaller sizes, a diaphragm slot filler inserted) it is heated in the water the required length of time and then removed from the heating vat, the top half of the mold immediately fitted to the bottom half, and the complete mold assembly containing the disc

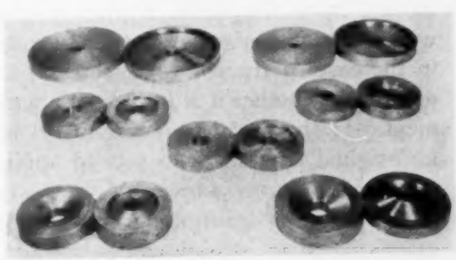

FIG. 2. Molding Dies for Various Sizes and Types of Meter Discs

placed under a heavy press and the cooling process begun.

Cooling of Remolded Discs

Gradual cooling of the mold and the disc is effected by means of a cold water spray applied to the outside surface of the mold while it is under compression in the press. The time required for thorough and adequate cooling of the disc is approximately twice the time required for the heating of the disc. A remolded disc which has not been thoroughly cooled throughout may become deformed when being withdrawn from the mold; therefore, it is important to provide for proper and complete cooling of the disc before removing it from the mold.

The remolded disc, having been removed from the mold, is then tested with a straight edge, or flat surface as in the case of the conical type disc, to determine whether it is in perfect alignment. If the disc has not returned to its original true shape, a second application of the process invariably corrects any traces of deformation remaining after the first straightening process. After the disc is straightened and in alignment, the edges are lightly scraped to remove any fins caused by the mold and the thrust roller hole in its periphery is reamed out to the proper size in discs equipped with thrust rollers. The disc is now ready for a simple grinding-in process in the measuring chamber to eliminate any scoring which might be present on the surface of the disc ball.

We have found that it is possible to straighten from 35 to 40 ⅝ in. or ¾ in. discs per eight-hour day by this process.

This remolding process is particularly applicable to all flat and conical types of meter discs of most standard makes from ⅝ in. to 2 in. in size, and can be successfully applied to discs of larger meters.

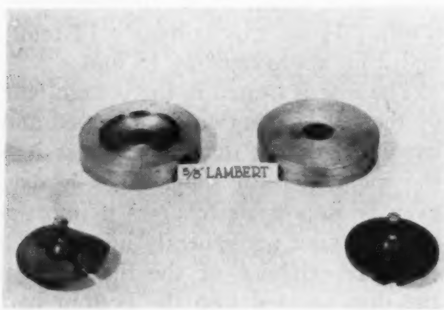

FIG. 3. Molding Die for ⅝-in. Lambert Flat Type Disc With a Burned and a Remolded Disc

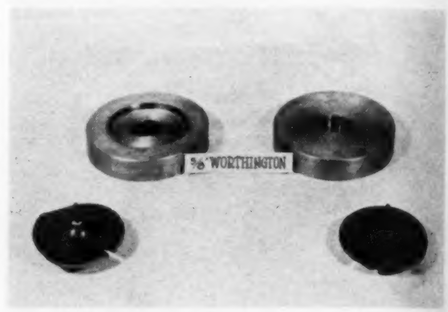

FIG. 4. Molding Die for ⅝-in. Worthington Flat Type Disc With a Burned and a Remolded Disc

Remolding Equipment

Heating Vat. The particular heating vat used in our shop for heating the discs (see Fig. 1) is an open type vat of 15 gal. capacity, heavily insulated, and containing a 220 v., 3000 w. and a 220 v., 2000 w. electric heating element, which were found necessary to maintain the water at 212°F. in this large vat during long periods of continuous remolding operations. A movable heating tray, upon which the disc

and the two halves of the mold are placed, is suspended within the vat to facilitate the lowering or raising of the disc and the mold into or out of the water.

Molding Dies. The molding dies were made of mild steel, "ASTM–A–10" (see Fig. 2), and were turned on the lathe in our meter shop. In determining the inside dimensions of the molding dies, it was necessary to establish the standard dimensions of new discs of each make, type, style, and size for which a mold was to be made, and from these measurements to increase the size of the mold sufficiently to allow for the contraction of the disc in cooling so that its finished dimensions would be as close as possible to those of a standard new disc. For the average ⅝ in. and ¾ in. flat type disc molds, 0.004

Fig. 5. Molding Die for ¾-in. Tropic Flat Type Disc With a Burned and a Remolded Disc

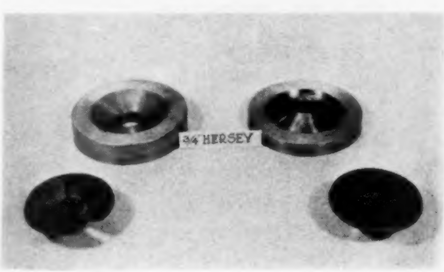

Fig. 6. Molding Die for ¾-in. Hersey Conical Type Disc With a Burned and a Remolded Disc

Fig. 7. Molding Die for 1-in. Worthington Flat Type Disc With a Burned and a Remolded Disc

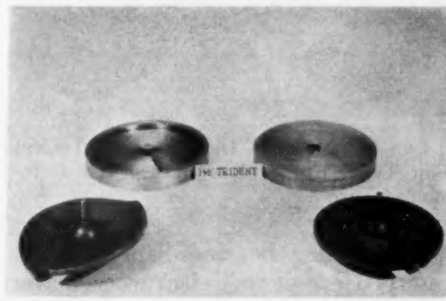

Fig. 8. Molding Die for 1½-in. Trident Flat Type Disc With a Burned and a Remolded Disc

in. oversize in diameter was necesssary; for ⅝ in. and ¾ in. conical type disc, from 0.002 in. to 0.004 in.; for 1 in. flat or conical type disc, from 0.005 in. to 0.010 in.; for 1½ in. flat type disc, 0.012 in.; and for 2 in. flat type disc, 0.014 in.

The hole for the disc ball in both the top and the bottom sections of the mold is made to the exact size of the ball of the disc.

The diaphragm slot inserts for the 1½ in. and 2 in. flat type discs, as well as of certain smaller sizes, are likewise made of mild steel, and are of the same dimensions, respectively, as the diaphragm slots of the standard discs. The use of these inserts is necessary to restrain the flow of the semi-plastic hard rubber during the pressing and

cooling process in order to retain the proper size of diaphragm slot. Molding dies for discs in sizes from $\frac{5}{8}$ in. to 2 in., inclusive (Figs. 3–9) illustrate the effectiveness of the process by showing a burned disc on the left and a remolded disc on the right.

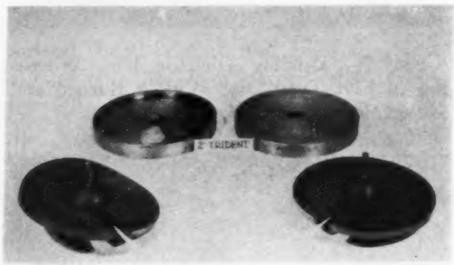

Fig. 9. Molding Die for 2-in. Trident Flat Type Disc With a Burned and a Remolded Disc

All molding dies and diaphragm slot inserts are kept well oiled when not in use to prevent rust and corrosion of their surfaces.

Press. The press used in this process (Fig. 10) was fabricated in our meter shop by using the top section (yoke and stem) of a 10 in. O.S.&Y. gate valve, which was bolted to a heavy steel plate, $1\frac{1}{8}$ in. in thickness, which in turn was fastened to a similar lower plate. The molding die is placed between these two plates and pressed tight by the pressure of a round plate loosely fastened to the bottom of the gate stem.

Figure 11 is a general view of the heating vat, molding dies, and press.

Performance of Discs after Remolding

During the development of the process and after it was put into operation as a regular shop procedure, considerable discussion developed as to the effect upon the discs of such heating and remolding. The bulk of this discussion centered around four questions enumerated below. Much time was spent in seeking the answers to these questions as we felt they were vital to the ultimate success of the project.

1. Q. Does the heat treatment and remolding process weaken or in any way damage the composition of the disc?

A. Laboratory tests and analyses of discs which had been burned and subsequently remolded as many as twelve times were made and compared with tests and analyses of new discs of the same make, type, and size. It was found that the discs which had been burned and straightened twelve times were not quite as strong as new discs but that their deflection was greater.

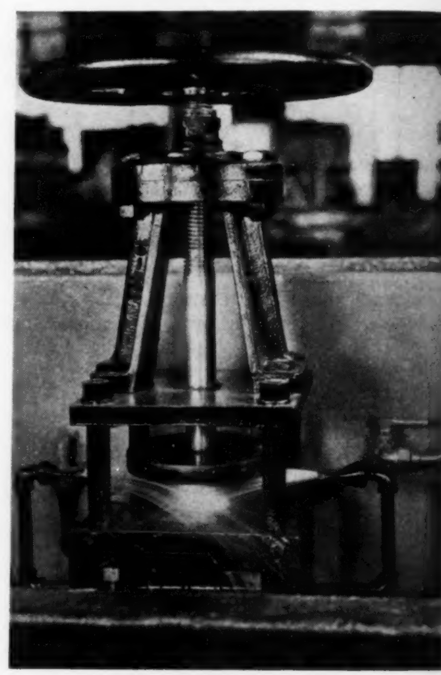

Fig. 10. Molding Die Press, Showing Molding Die Under Compression and Water Spray Being Applied

TABLE 1

Test of 20 ⅝-in. x ¾-in. Flat Disc Type Water Meters Showing Disc Dimensions and Registration Accuracy Test of Meters with New and Remolded Discs

Meter	Size	*Column No. 1* Registration Accuracy Test (New)			*Column No. 2* Disc Dimensions (New)		*Column No. 3* Disc Dimensions (Hot)		*Column No. 4* Disc Dimensions (Cold)		*Column No. 5* Disc Dimensions (After Remolding)		*Column No. 6* Registration Accuracy Test (With Remolded Disc)			Day Temp.	Hot Water Temp.	Cold Water Temp.
		Gpm.			Disc		Disc		Disc		Disc		Gpm.					
		16	2	1/4	Diameter	Thickness	Diameter	Thickness	Diameter	Thickness	Diameter	Thickness	16	2	1/4			
	in.				*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*						
1	⅝ x ¾	100.1	101.3	97.5	3.434	.1875	3.4575	.1885	3.420	.1895	3.436	.190	99.6	100.8	97.0	73	212	73
2	"	100.7	101.6	98.8	3.434	.188	3.457	.189	3.428	.189	3.436	.190	100.1	102.0	99.0	73	212	73
3	"	100.4	101.1	98.0	3.435	.188	3.458	.189	3.422	.190	3.4345	.186	100.0	101.2	96.9	69	212	73
4	"	100.1	101.3	97.7	3.434	.188	3.457	.1895	3.422	.190	3.4365	.185	100.1	101.8	97.0	69	212	73
5	"	100.9	101.2	97.3	3.435	.188	3.4575	.189	3.425	.190	3.434	.186	101.0	102.0	98.5	69	212	73
6	"	100.5	101.7	98.6	3.433	.1875	3.456	.1885	3.423	.190	3.4355	.1855	99.9	102.1	99.0	70	212	73
7	"	100.2	101.0	96.0	3.434	.188	3 4565	.189	3.425	.1905	3.435	.1865	100.6	101.7	96.4	70	212	73
8	"	100.5	101.3	99.3	3.434	.188	3.457	.189	3.426	.1895	3.4355	.185	100.3	101.8	99.0	69	212	72
9	"	100.1	101.5	95.3	3.4325	.188	3.454	.1895	3.426	.190	3.435	.185	100.0	102.2	95.9	69	212	72
10	"	100.3	101.0	98.0	3.434	.187	3.457	.1885	3.422	.189	3.4345	.185	99.9	101.2	97.5	69	212	71
11	"	99.9	101.4	97.0	3.4335	.188	3.457	.189	3.424	.1885	3.4345	.186	99.8	101.9	96.8	69	212	71
12	"	100.6	101.1	97.4	3.4335	.188	3.454	.1895	3.422	.189	3.435	.186	99.8	101.5	98.0	69	212	71
13	"	100.3	101.6	97.6	3.435	.188	3.456	.189	3.4215	.190	3.4345	.187	99.6	102.0	97.4	69	212	71
14	"	100.5	101.0	97.9	3.433	.188	3.456	.189	3.4245	.190	3.436	.1855	100.6	101.9	100.0	69	212	71
15	"	100.5	100.9	97.9	3.434	.188	3.456	.1895	3.423	.190	3.4365	.1855	99.4	100.9	96.0	69	212	71
16	"	100.7	101.1	97.4	3.433	.1875	3.456	.189	3.4205	.189	3.436	.185	100.0	101.4	98.0	69	212	71
17	"	100.5	101.4	96.5	3.433	.1875	3.454	.189	3.423	.189	3.435	.185	100.0	101.3	96.9	70	212	72
18	"	100.5	101.6	97.4	3.434	.1885	3.457	.190	3.4221	.191	3.435	.185	99.4	100.6	96.1	70	212	72
19	"	100.0	101.7	95.1	3.4355	.188	3.454	.189	3.424	.1885	3.433	.1855	100.4	102.0	98.6	70	212	72
20	"	100.3	100.9	96.1	3.434	.187	3.455	.1885	3.422	.189	3.435	.185	99.9	101.7	97.0	70	212	72

The slight changes in strength and rigidity of these discs under the extreme conditions of this test still did not render them impracticable for use.

2. Q. Would discs which had been in continuous service for many years respond similarly to relatively new discs in the remolding process?

A. From a series of tests it was found that discs which had been in continuous service from fifteen to twenty years responded to the remolding process in precisely the same manner as relatively new discs.

3. Q. Was it possible to restore them to their original thickness and diameter?

4. Q. What is the registration accuracy developed by meters employing these remolded discs as compared to the use of new discs?

A. To obtain answers to the last two questions we thought the best way to establish conclusive proof of the success or failure of the remolding process was to take a group of new water meters and progress them through the various stages of burning, disc remolding, and final registration accuracy tests, keeping an accurate record of each step.

Twenty new $\frac{5}{8}$ in. $\times$ $\frac{3}{4}$ in. positive displacement type flat disc meters, complying with the standard water meter specifications of the Department of Water and Power, City of Los Angeles, were selected at random from our stock for this test, without any knowledge as to their registration accuracy. The results of the test are shown in accompanying Table 1. These meters were first subjected to our required standard test flows of 16 gpm., 2 gpm., and $\frac{1}{4}$ gpm., as shown in Column 1 entitled "Registration Accuracy Test (New)." These meters were tested simultaneously, using our multiple testing system shown in Fig. 12.

Following the registration accuracy tests, the measuring chambers were removed from the main casings, the discs removed from the measuring chambers, and each disc and measuring chamber immediately marked so as to identify them permanently with that particular meter for the remainder of the tests.

Each disc was then carefully measured for its diameter and thickness. In Column 2 entitled "Disc Dimensions (New)" you will note that the disc diameters varied slightly, showing a difference of approximately 0.003 in. between the largest and the smallest diameters. Also, you will note that the thickness of the discs varied slightly, showing a difference of 0.0015 in. These dimensions are interesting to water works men for it definitely indicates that a variation in diameter of 0.003 in. and a variation in thickness of 0.0015 in. may still be expected in our present-day $\frac{5}{8}$ in. meter discs.

The next step was to determine the dimensions of these discs at 212°F. To accomplish this, the discs were placed in the heating vat of boiling water and left for five minutes. After being removed from the boiling water they were immediately measured for their diameter and thickness. The dimensions of these discs at approximately 212°F. are shown in Column 3 entitled "Disc Dimensions (Hot)." The figures show that discs having an average room temperature, which were subjected to a temperature of 212°F. for five minutes, increased in diameter on the average of 0.0222 in. and increased in thickness on an average of 0.00123 in.

Although most of the discs were

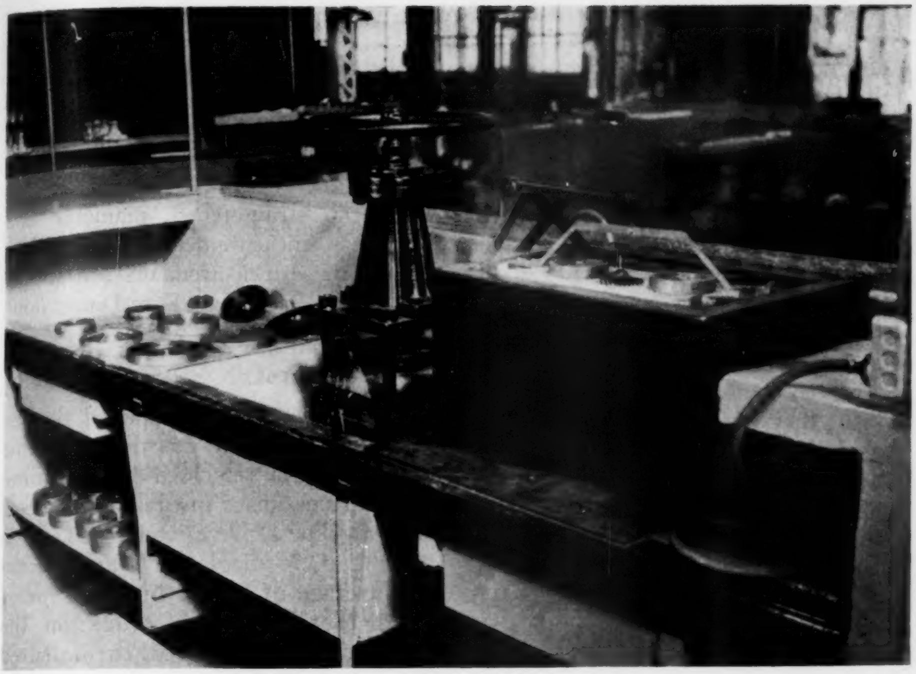

Fig. 11. Remolding Equipment, Showing Die, Press and Heating Vat

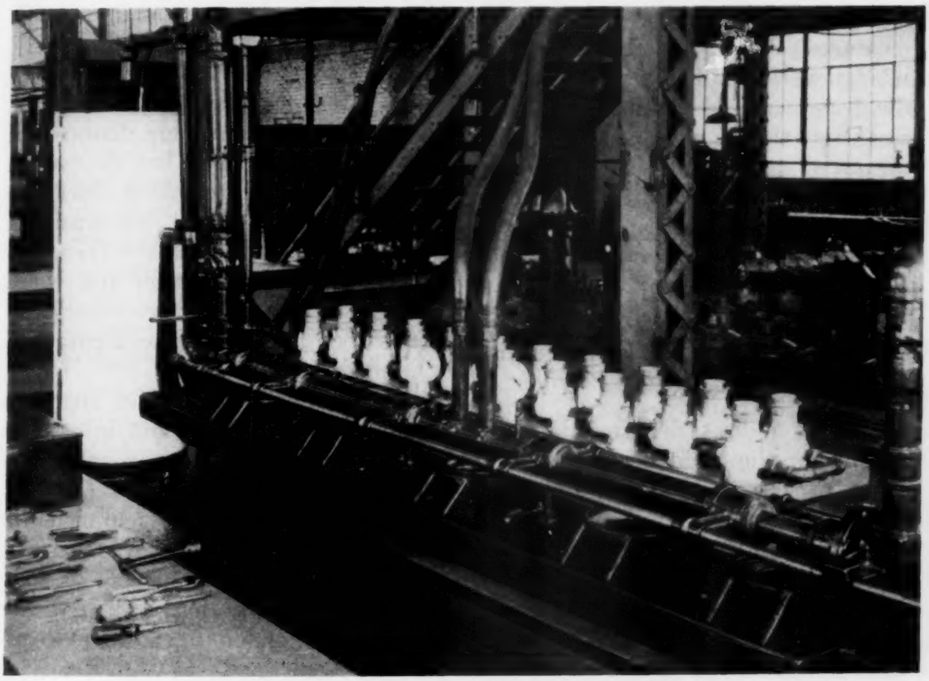

Fig. 12. Multiple Testing of 20 $\frac{5}{8}$-in. × $\frac{3}{4}$-in. Flat Type Water Meters Used in the Experiment

deformed by this first heating, it was felt that they should be subjected to further severe heating and a simulated burning operation performed as nearly like that as in actual service as possible. Therefore, the discs were fitted into the measuring chambers and the measuring chambers submerged in the vat of boiling water, allowed to stand ten minutes, then removed and the disc spindles rotated, forcing the discs completely out of alignment, after which they were immersed in cold water and solidified in their odd and varying shapes.

At this point and before starting the remolding process, further measurements of the discs were made. As shown in Column 4 entitled "Disc Dimensions (Cold)" we found that the discs when cooled had contracted on an average of 0.0106 in. below their original average new diameter and 0.033 in. less in diameter than when measured at 212°F. However, the tabulation shows that the thickness of the discs increased slightly and in some cases were thicker when cool than when measured at 212°F. There may be several reasons for the increase in thickness of the discs at this point of the test but I doubt whether they are worthy of any lengthy discussion as they are not particularly pertinent to the subject.

Remolding Process

With the discs distorted in shape and out of alignment, they were ready to be progressed through the routine remolding process. Each disc was then in turn fitted into the bottom section of the mold and, together with the top section of the mold, placed in the heating vat and heated for $2\frac{3}{4}$ min., after which the top section of the mold was fitted to the bottom section and the completed assembly containing the disc placed under compression and cooled with water spray for approximately 6 min. It was found that only one disc required a second heating and straightening application to produce perfect alignment. After all the discs had been straightened, diameter and thickness measurements were taken again; these measurements are shown in Column 5 entitled "Disc Dimensions (After Remolding)."

Accuracy Test

Inasmuch as this completed the remolding process, it was desirable now to compare the remolded discs with the original new discs insofar as diameter and thickness were concerned. Although these discs had expanded on the average of 0.0222 in. when measured "hot" and had shrunk on the average of 0.0106 in. when measured "cold," from their original average "new" diameters, they were restored to their original size within approximately 0.002 in. when remolded. The average diameter of the remolded discs was approximately 0.001 in. greater than the average diameter of the original new discs, but the average thickness of the remolded discs was approximately 0.002 in. less than that of the original new discs. These differences may seem large and would appear to have some detrimental effects upon the registration accuracy of the meters on low flows.

Therefore, the next and final step in the series of tests and inspections of these discs was to reassemble each meter, with its original disc (now remolded), and subject each meter to the same registration accuracy tests as applied in the beginning. The tabulated results of this final test are shown in Column 6 entitled "Registration Accuracy Test (With Remolded Disc)." All three rates of flow, including the one-quarter gallon per minute flow, were taken on the 10-ft. test

tank, which accounts for the percentage of accuracy being shown to tenths where applicable. On the 16-gpm. test, the average decrease of registration accuracy, using the remolded disc, was 0.36 per cent as compared to the original tests of these meters with new discs at the same rate of flow. However, the average registration accuracy of these meters (with the remolded discs) at this flow was still 100.02 per cent. On the 2-gpm. test there was an average *increase* of 0.31 per cent in registration accuracy as compared with the original tests of these meters with new discs. The average registration accuracy (with the remolded discs) for this rate of flow was 101.6 per cent. The ¼-gpm. registration accuracy test was by far the most interesting for it not only indicated that burned and sprung meter discs can be effectively used in meters after they are remolded but that the registration accuracy of the meters is not impaired. As the tabulation shows, there was an average *increase* of 0.21 per cent in the registration accuracy of the meters with the remolded discs as compared with the original new meter test and that the average registration accuracy of these meters (with remolded discs) at this rate of flow was 97.55 per cent.

However, this does not mean that a meter disc should be burned and remolded to improve its fit in a measuring chamber but rather that a meter disc which has become burned and sprung while in service can be remolded into perfect alignment for further use, and that the process is simple, effective, and economical.

Cost of Remolding Discs

To arrive at a cost per completed unit, a strict account was kept of all labor and material required to recondition a large number of each size, make, and type of discs for which we had molding dies and an average cost determined, which is shown in the following tabulation:

Average Cost of Reconditioning Warped Meter Discs

⅝ in. flat type disc	$0.25
⅝ in. conical type disc	$0.23
¾ in. flat type disc	$0.25
¾ in. conical type disc	$0.25
1 in. flat type disc	$0.27
1 in. conical type disc	$0.25
1½ in. flat type disc	$0.66
2 flat type disc	$0.71

From these cost figures it could hardly be said that the cost of reconditioning burned or sprung meter discs is an expensive operation, even for water meter repair shops that may find they have only a few dozen of these discs annually that would require processing. The difference between the cost of new discs and the expense involved in reconditioning even a relatively few damaged discs would easily pay for the equipment, which with reasonable care should last indefinitely.

It is the firm belief of the author that by continually striving to improve water meter repair techniques used in the meter shops, as well as by requiring greater durability and a higher degree of registration accuracy of new meters, a long range economy and greater efficiency in our metering equipment will result, which not only will prove beneficial to individual water utilities but also will reflect favorably on the consumers.

Grateful appreciation is extended to Mr. E. H. Thacker, Meter Shop Superintendent, Mr. Joseph McClees, Meter Repair Foreman, and other employees of our water meter shops for their valuable assistance in perfecting this water meter disc reconditioning process and in performing the various detailed tests outlined herein.

Abstracts of Water Works Literature

Key: In the reference to the publication in which the abstracted article appears, **34:** 412 (Mar. '42) indicates volume 34, page 412, issue dated March 1942. If the publication is paged by the issue, **34:** 3: 56 (Mar. '42) indicates volume 34, number 3, page 56, issue dated March 1942. Initials following an abstract indicate reproduction, by permission, from periodicals, as follows: *B.H.—Bulletin of Hygiene* (*British*); *C.A.—Chemical Abstracts; P.H.E.A.—Public Health Engineering Abstracts; W.P.R.—Water Pollution Research* (*British*); *I.M.—Institute of Metals* (*British*).

LAW, LITIGATION AND LIABILITIES

State Water Law in the Development of the West—*Rpt. to Water Resources Com., Natl. Resources Planning Bd. by Its Sub-Com. on State Water Law.* (*Published in abstract only.*) Studies limited to law of rights to use of water in 17 western states in which aridity makes water supplies scarce and valuable, so that water law much more highly developed than in eastern humid states. While in western states fundamental principles of water law often tested and proved workable, gaps and inconsistencies indicate legislative modification desirable and constructive. Field classified into main headings as indicated in following: *Surface Waters in Watercourses:* Stream system consists of main channel and all tributary channels. Water rights throughout stream system related and attached to both underflow and surface flow. Both common law doctrine of riparian rights and statutory doctrine of prior appropriation recognized although diametrically opposed in fundamentals. Former inherent in land contiguous to source of water supply without regard to time of use and latter depends on time of use without regard to location of place of use. Riparian rights on any one stream system correlative while appropriative rights exclusive. Water right a right to use but ownership of water in stream does not attach. Right to use is property right which is basis of water law. Courts of some western states have held that riparian doctrine adopted when those states adopted common law of England, humid country, and it has been modified to make it somewhat adaptable to arid conditions. Doctrine of prior appropriation developed by gold miners of Calif. and adopted in more arid western states (Ariz., Colo., Idaho, Mont., Nev., N.M., Utah, Wyo.) which at same time repudiated riparian doctrine. In remainder of western states (N.D., S.D., Neb., Kan., Tex., Calif., Wash.) riparian doctrine recognized in varying deg. but appropriative doctrine superimposed upon it. In Calif. riparian right remains paramount right, but in many other states recognizing doctrine riparian right relegated to position of minor importance. Riparian doctrine has less to offer as basis for utilization of water supplies than appropriation doctrine. Great complexities result in western jurisdictions in which riparian doctrine still paramount. Trend toward increasing restrictions on riparian right as development under such right minor factor in irrigation. Basic elements of appropriative right: quant. of water, period in yr. use made, point of diversion, purpose and place of use and date of appropriation. Last item relates it to all other rights on stream system. Each right junior to all other rights on stream system having earlier dates of appropriation and senior to all having later dates. Each right can divert water only after flow sufficient to satisfy all senior rights whether up or down stream. No administrative mchy. can be set up for control of riparian rights because of their nature but such procedure for appropriation rights highly developed throughout west. In most states central office for filing applications created. After investigation, if necessary, office acts on application. In various degrees streams policed to regulate diversions

after adjudication of rights made and this can apply to riparian rights also. From navigable streams diversions cannot be made if actual navigability interfered with. Purpose of use must be beneficial and definition of term very broad. Generally, domestic use defined as highest use with irrigation second. Water may be appropriated for storage and subsequent release for use. Natural channels may be used for conveyance of water previously reduced to control. Water generally cannot be used outside of watershed under riparian right but no such limitation generally applicable to appropriative rights. Within certain limitations peculiar to laws of few states, changes in point of diversion, place of use and character of use may be made if other rights not damaged by change. Thus, change from use to generate elec. power, non-consumptive use, to use for irrigation, consumptive use, can generally not be made. Ownership of water rights can be transferred unless state law makes them appurtenant to particular piece of land for which they were appropriated. Rights may be lost by abandonment, forfeiture through non-use during period of years set by statute, adverse use for prescriptive period and estoppel. Appropriations cannot be made in one state for use outside state unless authorized by statute. In some states expressly forbidden by statute, while in others appropriations of this nature may be allowed if water to be used in neighboring state in which reciprocal statute exists. In several interstate suits over waters of stream system principle established is that several states entitled to equitable apportionment of benefit from stream in question, but does not mean equal div. of water. Interstate compacts adopted as another method of apportioning waters of interstate streams. Such compacts must be ratified by respective state legislatures and usually by Congress. Such compacts binding on all water claimants from stream in each state involved as rights of water users derived from state whose right in turn defined by compact. Water may be salvaged by saving it from natural loss and recovering it for use, and new water may be added to natural supply by development works. Such waters belong to entity which has salvaged or developed water if it can be shown they have not been used previously by prior rights. Water consumed (evaporated) by growing plants and hence irrigated areas consume water. Impossible to regulate diversions so there will not be surface waste from ends of conveyance systems. Loss occurs from unlined conduits and water placed on fields must be in excess of consumption of vegetation to carry off salt accumulations, and because impossible to limit application of water to exact amt. which can be held in root zone. Hence, water which percolates finally disposed of by evapn. from local swamps or finds its way into natural channel. Called "return flow." Law as to return flow and waste in highly formative stage, principal conflict being as to whether entity whose operations gave rise to return flow and waste has right to recapture or whether it should be treated as amplification of stream and thus appurtenant to rights below its inflow. Return flow common phenomenon along any stream used for irrigation and extensive developments predicated on its continuance. When return flow enters watercourse without assertion of right to recapture, it unquestionably inures to benefit of rights to natural flow. Assertion by original appropriator of right to recapture return flow after it has entered watercourse or to make it available to another agency, upheld in several cases where assertion made either at time of appropriation or where activities made it evident that on appearance of return flow its use according to previous plan contemplated. Recovery of deep percolation while within limits of the irrigated area from which it occurs and before it reaches natural channel as return flow permissible if used on same area, i.e., return flow can be prevented, if necessary, for use in area which gave rise to it. In Colo., seepage from reservoirs appurtenant to stream and cannot be recovered by owner of reservoir. In decisions where return flow and waste are from water foreign to watershed, they variously hold that abandoned fugitive waters both are and are not part of stream, and if not part of stream that exclusive appropriative rights both can and cannot be acquired for use. In general, claim of right to recapture by importer even without expressed intent better than in case of non-foreign waters. As against claim of ownership by states of waters within their borders federal govt. long held view that U.S. owns non-navigable waters although states own navigable waters subject to control by the U.S. for navigation. Difference due to distinction under common law which makes water in beds of non-navigable streams, etc., property of riparian owners. U.S. claims

that it became sole owner of water of western half of U.S. by title from various other countries from which this area acquired and that it has never parted with title except as it has permitted appropriation under state laws. State has, therefore, no control over unappropriated water. States oppose this interpretation, claiming that Congress has dedicated all waters for use of public and that thus they have been made subject to appropriation under laws of states. States do not claim ownership in proprietary sense and claim no ownership in water but merely in use of water; therefore U.S. cannot own water as claimed. Question now before Supreme Ct. in *Nebraska* v. *Wyoming* in which Colorado impleaded and U.S. intervened. *Diffused Surface Waters:* Either flood waters which have escaped from stream or water on its way to stream which has not yet reached definite channel. Latter has its source in rainfall, melting snow or seepage and springs. Although such waters may be important portion of supply to appropriators from stream system, courts, and in few states statutes, consider such waters as in ownership of landowners across which they are passing, and thus treated as a thing apart. *Spring Waters:* Appropriations of spring water on public lands protected even if the land subsequently patented. If springs do not flow off tract on which they originate they ordinarily belong to owner of land. Springs that are sources of streams or contribute to them subject to general water law of state in regard to surface waters. *Ground Waters:* Use of ground water lagged behind use of surface water and similarly development of law of ground water lagged behind that of surface water. Appropriate rules of law matters of importance because area irrigated from gravity sources virtually static for past 20 yr. while area irrigated from wells increasing rapidly. Hydrologists maint. that "ground water may be considered as flowing in definite water course or channel whose boundaries are boundaries of water-bearing formation even though 'water channel' thus defined . . . may be miles wide." Court decisions commonly classify ground water as (1) definite underground streams and (2) percolating waters, and apply different doctrines of law in many states. Regardless of classification, one principle should be applied whether water for time being on surface or underground. Should be no distinction between artesian and non-artesian waters. Defined subterranean streams and underflow which supports surface stream subject to same rules of law as surface streams. Application of different rule of law to so-called percolating waters unfortunate and makes for confusion. Underground waters in western states subject to 3 general legal doctrines: (1) English or common-law doctrine of absolute ownership in land overlying ground water source. (2) American doctrine of reasonable use by overlying land which is similar to riparian doctrine as modified for conditions in western states. (3) Appropriation doctrine which applies to ground water same principles as applied in appropriation doctrine of surface waters. In English doctrine water treated as mineral which can be extracted in any amt. by anyone who has access to it, and taken to distant lands or wasted since no requirement of beneficial use. Possible injury to another dependent on same source not recognized. In N.D., S.D., Tex., Mont., Wyo., Ariz. and Kan. (except northwest) this doctrine recognized by statute or court decision. In American doctrine of reasonable use, recognized that impossible for any land owner to use common underground supply without diminishing it and thus probably diminishing supply available to others overlying same source. Reasonable use difficult to define but Calif. courts in effect defined reasonable use as use which will not deprive others overlying source of like reasonable uses. This came to be known as rule of correlative rights, i.e., rights of all owners of overlying land correlative and equal and hence would be to reasonable proportion of supply in time of shortage. American rule, although not necessarily correlative doctrine, adopted by Neb., Okla. and Wash. In Calif. law of ground water fully reconciled with 2 doctrines of surface water law. In other 3 states which have both appropriation and riparian doctrines of surface water rights, development of ground water law verging toward that of Calif. Appropriation doctrine prevails by statute in Idaho, Nev. and Utah where all ground waters subject to appropriation. In Colo. doctrine applied to percolating waters by court decisions but not by statutory law. In N.M. and Ore. east of Cascades statutes make ground waters of certain designated classes subject to appropriation. Kan. statute authorizes "diversions" of ground water in northwestern part of state. Therefore, in Idaho, Nev., Utah, Colo., N.M. and Ore. (east of Cascade Mountains) the ground water law and surface

law thus reconciled under appropriation doctrine, while in Calif., Neb., Okla. and Wash., practically or entirely reconciled under common-law doctrine, leaving matter unreconciled in remaining western states. In those states which follow English rule, result may be most unfortunate, as this rule particularly unsuited to arid conditions, having originated in humid England long before science of groundwater hydrology well formulated. Now with development of this science English rule has no place in water economy. Co-ordinated development of stream systems impossible where ground water under English rule of law. American rule with its correlative rights adaptation long step in advance but, nevertheless, has inherent weaknesses. Like riparian right, based on position of land, i.e., it inheres in land overlying and in contact with underground supply, regardless of fertility of soil. If supply developed to its limit by portion of overlying area that portion has no security because all remainder of overlying area continues to possess right just as good as that of developed lands, for right not lost by non-use. This doctrine developed by courts and is not statutory doctrine. Theory of courts is that one who develops more than his fair share should have no complaint if he, by judicial apportionment, later deprived of part of it. This argument has little force because impossible for any individual to det. his fair share. Practical value of judicial apportionment of pro rata share of water virtually nil, as evidenced by fact that in Calif., although doctrine enunciated 40 yr. ago and although many ground water units in which shortage drastic and individual water users suffering from shortage, no legal proceedings toward adjudication of rights started except one started lately now under way in southern Calif. (This started *after* importation of water from other sources assured and deemed necessary to prevent depletion of ground water basin, to allocate water rights and to det. who should pay for outside water.) Rule encourages over-development for no control but judiciary, while water rights under appropriation doctrine can be administered by statutory bureaus. Appropriation doctrine seems best suited to highest development. Major defect is that it is based primarily on priority and thus fertility of soil not considered. However effective doctrine is or may be, effectiveness depends on admin. which in many cases weak, uninformed and lacking in vision. Report makes 41 conclusions and recommendations for modification and betterment of water law. Most recommendations based on appropriation doctrine. Only most important summarized: *Conclusions and Recommendations:* Doctrine of prior appropriation has met needs of West in far greater deg. than riparian doctrine. Tendency toward control to inhibit waste or water increasing. First step was in elimg. or redefining riparian right. Important factors contributing to waste: excessive appropriations; inefficient methods of diversion, conveyance, distr. and use; and excessive channel losses. Modification of rule of strict priority may become necessary. Legislation in itself ineffective. Sympathetic co-operation of courts and administrators necessary. Authority to reject applications for permits offers means toward efficient utilization of water. Statutes allowing change in point of diversion, etc., desirable. Such changes should not be allowed if contrary to public interest. Limitation should be placed on permissible channel losses in delivering water to early down-stream priorities. Some problems capable of physical solution. Legislation enabling constr. agency to secure all possible advantages from use of return flow from its own development would be in interest of efficient utilization of water. Existence of unused riparian rights in some states formidable obstacle to best development. Public interest would be served by placing reasonable limit on time within which riparian rights may be exercised and with provision for loss of rights for failure to do so. Central state office for control of water rights best. Admin. of diversions from streams to protect prior downstream water rights necessary in many cases, but in admin. of long stream systems where strict adherence to priorities difficult and productive of waste, public interest would be better served by administering stream in sections and apportioning supply among claimants by such units. Practicability of pro-rating water in time of shortage subject to compensation to senior appropriator merits study. One legal principle should be applied to all ground waters susceptible to control and appropriative doctrine best adapted.—*H. Conkling.*

The Driller and the Law. A. L. H. STREET. The Driller **17:** 2: 20 (Feb. '43) (*Previous articles of series abstracted* Jour. A.W.W.A. **35:** 352 ('43).) *Case*—Schofield *v.* School Dist. No. 113 (184 Pac. 480): Drilling contract

called for drilling "water well" at $1.25 per ft., payment to be made "on completion of well." At 24′ driller struck surface water and cased it out. At 80′ he hit salt water, but owner stopped job, although no usable water found. Kan. Sup. Ct. decided contractor entitled to be paid at agreed price for total depth drilled. *No Guarantee Implied:* Kan. ct. approved declaration by Mont. ct. to effect that contract to drill "well" does not mean agreement to drill hole with suitable water therein, but one drilled in attempt to get water. Kan. ct. held term "water well" indicates merely hole being drilled to look for water, not that satisfactory supply will assuredly be obtained. Ct. adds: contracts for digging or drilling well often provide payment dependent upon obtaining water; but to be given that effect, such purpose ought to appear by express statement or very clear implication, especially where contractor does not choose site. *Other Decisions Cited:* Kan. ct. cited decisions by Neb. and N.Y. cts. holding that, where contract does not call for specific flow of water, well must be paid for regardless whether flow obtained much or little. Tex. and Ala. decisions cited on point that mere guaranty to produce water does not guarantee water suited to owner's needs. *Reasonable Depth Sufficient.* Kan. ct. stated: even under contract to prosecute boring well until other party satisfied, or water found, has been said no obligation thereby created to go beyond reasonable depth. In case Bohrer *v.* Stumpff (31 Ill. App. 139), well contracted for regarded as completed when apparent good water not obtainable within reasonable depth, condition established from plaintiff's viewpoint by director's order to discontinue drilling. *Ibid.* **17:** 3: 14 (Mar. '43). *Handle Progress Payments Carefully:* Landowner agreed, but failed, to pay well drilling contractor $3.50 per ft., half of contract price, as work on well progressed in 50′ intervals. This slowed work because contractor compelled to reduce force for lack of funds to pay wages. After completing job, contractor sued for balance due. Owner counter-sued for damages claimed through contractor's failure to complete work within reasonable time. Contract contained no time limit provision. Law, therefore, implied promise to finish job within reasonable time. Driller won both suits. For legal protection in such circumstances, author recommends driller serve written notice on owner stating no. of ft. drilled, amt. due as progress payment and request for payment; driller to retain copy. In question of agency, rule of law not bound by act of member of family in business matter unless authorized specifically to act. *Contractor Needs Sound Security:* Opinion rendered by N. J. Ct. Errors and Appeals warns that where owner of doubtful solvency, and driller counts on lien right, driller should make certain to get sound security. *Ibid.* **17:** 5: 14 (May '43). *Driller Gets Nothing per Foot:* Every ct. decision denying well contractor right to collect for work affords extremely valuable legal lesson for every driller willing to study it. In case, *Ylijarvi* v. *Brockphaler*, Minn. Supreme Ct. held that, where contractor agrees to drill producing well according to certain specifications and is to be paid upon job completion, not entitled to collect until water produced. Contractor not only guaranteed adequate supply of usable water but also negligently failed to put agreement and modifications in writing. Lost suit against landowner as well as labor and materials. Ct. recognized instances where *slight* and *unintentional* departures from contract specifications will not prevent contractor collecting contract price, less reasonable amt. to compensate owner for defficient performance, but noted that deviations or lack of performance, intentional or so material that owner does not get substantially that for which he bargained, not permissible. *Ibid.* **17:** 6: 16 (June '43). WM. S. MALLOY. *The Meaning of "Workmanlike Manner":* Case, *Roscoe Moss Co.* v. *Jenkins* (130 P. 2d 477, decided Nov. 2, '40). Driller sued to collect amts. due under contract for drilling water well on defendant's land. Latter counterclaimed for: (1) loss of valuable lease upon property through plaintiff's failure to develop sufficient water through not drilling in good and workmanlike manner; and (2) breach of warranty, in that plaintiff allegedly recommended rotary drilling although, according to defendant, method not best for properly drilling well. Contract terms detailed, including provision driller did not agree to find or develop water but did agree to drill well in good and workmanlike manner. Work stopped at 290′ on defendant's instructions and cased to 282′. Completed well pumped 600–700 gpm. but not considered usable. Trial ct. found for plaintiff. Upon appeal, appelate ct. held that burden of proof of performance in workmanlike manner rested upon plaintiff to allege and prove performance of all conditions in agreement, as was done in this case. Not necessary to prove compliance at every small step in

drilling process, unless defendant produced evidence that, in specific operations, work defective in specified respects. Ct. found defendant overemphasized clause: "in good and workmanlike manner." *Ibid.* **17:** 7: 14 (July '43). A. L. H. STREET. *Safeguarding Buyer Against Seller:* Driller built up well-drilling business in St. John's County, Fla. For $900, sold equip., rights and interest in business. Contract provided that driller would not "engage in business of drilling wells" in county for 10 yr. Yr. later, buyer sued to enjoin breach of last part of agreement, claiming driller drilling well for another driller and threatened to carry on business. Defendant replied merely working for another driller who had right to compete in county. Fla. Supreme Ct. held covenant violated. *Ibid.* **17:** 8: 16 (Aug. '43). *No Pay for Incomplete Well.* Circumstances under which well contractor may be unable to collect for work or materials supplied in drilling and equipping well shown by Tex. Ct. of Civil Appeals decision at Amarillo. Decision suggests 3 important things for every well contractor to consider before undertaking job: (1) Explicitly state conditions repayment in event well abandoned due to casing collapse or other cause. (2) Unconditional agreement to drill and equip well does not entitle contractor to payment unless contract fulfilled; barring, perhaps, cause for which landowner at fault. (3) Supplying defective casing under driller's contract risky business. *Ibid.* **17:** 9: 18 (Sept. '43). *Brevity in Contract Is Dangerous.* In case decided by R.I. Supreme Ct., contract contained provision: "First party agrees to drill artesian well on premises of second party at rate of $2 per ft." Such contract contains 3 important weaknesses: (1) mutual definition of "artesian" not made; (2) fails to fix max. depth contractor must drill or be regarded in default in performing contract; and (3) unless driller intends to bring in "artesian" well, contract dangerously worded as many cts. would probably say well without water not "artesian." When contractor unwilling to guarantee striking water, or to guarantee min. vol. yield, contract should contain appropriately worded clause disclaiming such guaranty, to avoid future disputes as to his implied or expressly made guaranty. *Ibid.* **17:** 10: 14 (Oct. '43). *Liability for Personal Injury.* Mere fact person acts on suggestion by another and thereby injured, suggester not liable for accident. While excavating open well in N.C., plaintiff contractor lowered by block and tackle to adjust terra cotta piping. Stood on hook and held to tackle with hands. One owner suggested contractor stand on block. In shifting to new position he slipped, fell and injured self. Ct. upheld owners 2-point defense: (1) plaintiff not their employee, but independent contractor, and (2) neither owner negligent nor in any way contributing to accident. *Ibid.* **17:** 11: 14 (Nov. '43). *Conflicting Water Rights.* Desirable in given cases to locate well some distance from boundary line rather than close thereto. Instance of 28′ well on Ky. farm, close to boundary line. Coal co. owned adjacent land and drilled coal hole 60′ away to det. thickness of underlying coal seams. As result, farm well drained. Later, water rose to 14″ depth compared with previous 4½′, when co. filled coal hole with cement. Farm owners sued for damages and trial ct. awarded judgment. Appeals ct. set aside verdict. *See* Sycamore Coal Co. *v.* Stanley (292 Ky. 168, 166 S.W. 2d, 293). Ct. held that when putting land to legitimate use, landowner not liable to adjoining landowner for injuries to wells or springs fed by hidden underground streams flowing in unknown channels. *Drilling on Wrong Land.* Mere fact that drilling well may constitute valuable improvement does not necessarily impose liability on landowner to pay for well if same not sanctioned by word or action. Now considering liability of landowner's interest to mechanic's lien on acct. of well drilled at tenant's instance. *See* Ky. Power Co. *v.* Norton Coal Co. (93 Fed. 2d. 923). Coal co. owned land adjoining tract owned by its subsidiary corp., a power co. An officer of both designated 2 well sites, believing both on latter land. Actually, one on coal co. land. Circuit ct. decided no lien assertable against coal co. because of benefit accruing to it through mislocating well, applying gen. rules of law denying to trespassers rights based upon their trespasses and which deny relief to persons sustaining loss through own negligence. *Ibid.* **17:** 12: 16 (Dec. '43). *Exercise Caution in Guaranteeing Water Purity:* Occasionally, well contractor may find local conditions warrant special caution in guaranteeing *pure* and *wholesome* water. Prudent to include in contract clause embodying idea: "The contractor shall not be responsible for wholesomeness of water due to artificial conditions not caused by him." In case, U.S. Circuit Ct. of Appeals, 6th Circuit.—Sinclair Refining Co. *v.* Bennett,

(123 Fed. 2d, 884) Ct. upheld damage award to landowner re contamn. of 2 water wells by gasoline leakage from nearby storage tanks, stating, in view of uncontradicted testimony, that known gasoline contamd. wells not cleared for many yr. and that plaintiff's wells not cleared of gasoline odor often 5 or 6 yr., deemed injury, if not absolutely permanent, irremediable except after lapse of unpredictable period and that, therefore, instruction on damage measure not erroneous.—*Ralph E. Noble.*

Validity of Sanitation Laws. LEO T. PARKER. Sew. Wks. Eng. **14:** 370 (Aug. '43). Recently, higher ct. established 3 unusually important legal elements pertaining to poln. by sewage disposal: (1) munic. authority to establish sewers and provide plans for their constr., "legislative authority" unabdictable by municipality through contract; (2) poln. of running stream permanent nuisance; and (3) statute of limitations effective re latter. Although munic. authorities agree in contract that acts of polg. running stream temporary nuisance, and city will make future payments, therefore, property owner not entitled to payment if he delayed filing suit beyond limitation period specified by state law. Points clearly illustrated in case of *Stewart v. City of Springfield*, (1655 S.W. 2d, 626, Oct. '42)—*Ralph E. Noble.*

Sanitary Regulation No. 1 Adopted by the State Water Conservation Commission. ANON. Official Bul. N.D. Water & Sew. Conf. **11:** 1, 2, 3: 8 (July–Aug.–Sept. '43). No system for sewage, indus. waste, garbage, or refuse disposal, tending to pol. water courses, shall be installed by any pub. agency or by any person or corp.; nor shall any such existing system be materially altered or extended until satisfactory plans and specifications for installation, alteration, or extension, together with such information as state water conservation com. and state health dept. may require, have been submitted in duplicate and approved by above agencies; and no constr. occur except according to approved plans.—*Ralph E. Noble.*

IMPOUNDING RESERVOIRS

The Control of Reservoir Silting. CARL B. BROWN. U.S. Dept. of Agric. Misc. Bul. *No. 521* (Aug. '43). Water storage vital cog in U.S. war production economy. Our 9000 larger dams and impounding reservoirs costing nearly 5 billion dollars, supply $\frac{1}{3}$ of nation's elec. power; water to areas used by $\frac{1}{6}$ of pop. and about $\frac{1}{3}$ of war industry; and irrigate lands producing 5% of annual agric. products. Many vitally important reservoirs losing 1, 2, 3 and 5% of capac. annually by silting from soil erosion on agric. and range lands. Some important reservoirs filled up in 1–5 yr. Nearly 2000 small ones filled to top with erosion debris from unprotected fields and pastures. Annual cost of reservoir silting approx. 50 million dollars. In recent 3-mo. period, silting in certain southern power storage reservoirs reduced elec. production 90 million kwh. Many community supplies endangered because reservoirs $\frac{1}{4}$ to $\frac{1}{2}$ sediment filled while demand 2 to 3 times normal. Report describes and appraises all known control methods many of which immediately applicable. Watershed control and soil conservation measures especially emphasized as only practical way of permanent reservoir protection. Not practical to clear reservoir or replace site. Soil conservation must be accelerated on reservoir watersheds to protect these vital links in war economy. Reservoir silting primarily caused by accelerated soil erosion, results from deposition of streamborne soil waste or sediment when stream transporting power suddenly diminished by flow into quiet impounded waters of reservoir. Reservoirs of equal size but different use not damaged equally. Those for: *Power.* Only to extent usefulness dependent upon storage. *Water supply.* By any storage capac. reduction below safe min. to meet needs in case of droughts, fires, or other emergencies. *Irrigation.* To extent of loss by evapn. and over spillway due to sedimentation. *Flood control.* To extent sedimentation reduces storage protection against less frequent but larger vol. floods. *Navigation.* To extent ships shoaled and dredging required. *Recreation.* Aside from progressive sedimentation leading to reservoir abandonment, sediment creates conditions unfavorable to fish life, accumulates on sandy swimming beaches, causes swamping at lake inlet and shores providing malaria hazard. Proposed or tried methods for reser-

voir silting control: (1) selection of reservoir site, (2) reservoir design, (3) sediment inflow control, (4) sediment deposition control, (5) sediment deposits removal, and (6) watershed erosion control. (1) and (2) disregard possibility of changing rate of sediment output from drainage area or deposition control in reservoir but depend upon location and size for long life. (3), (4) and (5) accept fixed reservoir size and fixed rate of sediment production but attempt to prevent all or part from permanent deposition by various means. (6) attempts to reduce sediment reaching reservoir. Sound policy requires impartially considering all 3 philosophies and selecting available methods physically possible and economically feasible under given conditions. Carefully weighing advantages and disadvantages of various methods before definitely locating and designing reservoirs most likely to give best solution. When only 1 site available, first possibility of sedimentation control elimd. When reservoir designed and built, one or more addnl. possibilities, forfeited. After sediment deposited, few possibilities left. Proper planning at earliest stage leads to greatest return. Each silting control method discussed in detail and followed by appraisal. Phases covered: developing suitable capac.-watershed ratio; raising dam; installing adequate outlet works; settling basins; vegetative screens; off-channel reservoirs; bypass canals and conduits; venting density currents; control of waste-water release; excavation; dredging; draining and flushing; flood sluicing; sluicing with controlled water; sluicing with hydraulic and mech. agitation; sediment sources; land use effect on erosion; erosion control methods; efforts in watershed erosion control; and planning for watershed control—an appraisal.—*Ralph E. Noble.*

Stratified Flow in Reservoirs and Its Use in Prevention of Silting. HUGH STEVENS BELL. U.S. Dept. of Agric. Misc. Bul. *No. 491* (Sept. '42). Large reservoirs serve many purposes. In arid and semiarid West, primary use to conserve water for irrigation but frequently, also, to provide power and water for indus. and domestic needs. May play vital part in river regulation or flood control, recreation and as wild life refuge. Stratification affects these interests, yet often not specially considered because many reservoir outlets constructed as though water all one qual. and only quant. discharged should be controlled. Given versatile outlet system and inventory of strata within reservoir, operator familiar with density current behavior can do much to provide consumers with qual. and quant. of water desired. More than just large container with adjustable outlet, reservoir huge machine upon which exceedingly complex civilization growing steadily more dependent for food, drink, power, flood protection and recreation. Most efficient operation dependent upon knowing density current behavior and utilization. Skillful planning may conserve part of storage capac. normally destroyed by fine sediment deposition. Entirely possible to supply water to seal new canals, destroy weeds in old ones or improve soil of sandy farms. Usually impossible thus to operate existing reservoirs because: (1) outlet works design completely disregards opportunities inherent in stratified flows; and (2) small amt. of special required knowledge unavailable to operator. Broadly, density current a gravity flow of fluid through, under, or over fluid of approx. equal density. Term used interchangeably with "stratified" or "density flow." River flowing under air is gravity flow, not density current, as water density approx. 800 times that of air. Thus, by definition, surface streams not density currents. Cold river at 60°F. entering warm lake at 67°F., however, may continue as separate stream to lowest part of basin. Such river water will be approx. 1.0008 times heavier than lake water. Density differences of 2 waters at least 10 times that necessary to assure stratified flow experimentally. Density currents range from invisible ones traceable to dissolved salts or temp. differences, to visible ones of muddy origin. Elec. thermometers, conductance cells, current meters and water samplers greatly aid in detg. characteristics. *Stratified flows* illustrated by: muddy density current, dust storm, cold front, smoke screen, fog bank, etc. Turbid *underflow* observation in lakes and reservoirs usually difficult but frequently indicated by accumulated mass of debris where muddy river plunges abruptly beneath clear reservoir. River-borne driftwood and other material stopped by upstream surface current in reservoir, and reservoir current-borne debris stopped by inflowing river. Density current *overflows* commonly occur when ordinary streams enter salt water bodies or when warm streams discharge into comparatively cold lakes. Unless, turbid, overflow invisible. Air travelers along sea coasts frequently note semicircular areas of muddy water, with demarcation sometimes

sharp. Clouds provide most familiar example of *interflow* when 2 or more strata, differing markedly in temp. and often separated widely by clear air, flow in different directions. When different colored rivers unite, they may flow side by side as distinct streams for many mi., but possible only if 2 waters have essentially same density as when slightly turbid river unites with cooler and clearer one. If density difference only a few hundredths of 1%, heavier stream will sideslip promptly beneath lighter one. When stratified flow begins in liquids, latter sometimes behave as gases. Turbid underflow illustrates point. Immediately after entering reservoir, turbid stream produces turbulence as waters mix. Suddenly, dild. turbid water plunges beneath surface and continues flow as separate muddy stream but with slow motion characteristics and every movement exaggerated. If submerged channel on reservoir floor, muddy current flows therein, climbs to surprising heights on outside of slight bends, even abandoning channel at sharp turns, tumbles over submerged falls with deliberateness of feather settling in calm air and leaps lightly over seemingly impassable barriers. Underflows behave like dust clouds; clouds of dusty water flowing under clear water as cloud of dusty air flows under clear atm. Archimedes principle involved. Turbid underflow definitely immersed in liquid of almost equal density and consequently buoyed up by force nearly own total wt. Only suspended sediment prevents it from floating. After muddy underflow reaches dam 3 things may occur: (1) if lake shallow and discharging over spillway crest, part of muddy water included; (2) remaining muddy water may form submerged lake from which much can be withdrawn if necessary outlets available; (3) if lake deep and outlets at relatively high levels, then underflow must come to rest as submerged lake in which suspended sediment will settle slowly many months. Submerged lakes change underflows to interflows in response to density changes by sedimentation. Behavior of overflows and interflows described. [Reasonable that foregoing principles function importantly in water poln. by domestic and indus. wastes.] *Some Factors Governing Withdrawal of Layers:* Submerged outlet draws homogeneous water toward it from all directions. When water stratified, possible to withdraw from single layer. Unless outlet drain small in relation to layer thickness, or withdrawal rate slow, or density difference between adjacent layers great, not likely to confine withdrawal to single stratum. If confined to one layer, latter must flow toward outlet rapidly enough for demand. Over- and underlying waters often interfere when density differences too narrow. If one layer to supply entire discharge, adjacent layers must be buoyed up or held down by force greater than exerted upon any portion of them by outlet. Some possible applications of stratified flow vividly depicted to emphasize practical advantages stressed above. Quant. of sediment carried by underflows estd. from data gathered by U.S. Bur. of Reclamation at Lake Mead, Boulder Dam. By May 20, '40, stored sediment reached impressive total of 232 million tons. With proper outlet facilities, 75–90% could have been carried beyond dam by stratified flow, thereby increasing life of dam from 200 to 240 yr. Impounded sediment-laden water will not move readily if concn. exceeds 18.6 lb./cu.ft. Its discharge cannot be indefinitely postponed, therefore, without serious consequences. Deposition of suspended material decreases reservoir bottom slope, thus reducing size and quant. of material transported by slower flow. Examples cited. Consistent and intelligent use of stratified flows can do much to solve present and future reservoir problems.—*Ralph E. Noble.*

Notes on Reservoir Silting and Suspended-Load Measurements in Washington. L. C. GOTTSCHALK. U.S. Dept. of Agric. Soil Conserv. Service, Special Rpt. No. 2. (Oct. '42). Storage reservoirs in U.S. play vital role in indus. and agric. production, supplying water for domestic, indus., irrigated agric. and power on vast scale. In many sections, storage reservoirs being rapidly sabotaged by silting from accelerated soil erosion. State of Washington, however, generally free of such problems, seriously. Ests. of capac. losses reported based on reconnaissance surveys consisting of measuring sediment thickness at few well distributed locations in reservoir and calcg. ratio of sediment vol. to original storage capac. Such surveys made on several hundred reservoirs in U.S. for estg. general magnitude of silting. Not intended for comparing accumulation or erosion rates in watershed areas, but sufficiently reliable to indicate reservoir longevity in tens, scores or hundreds of yr. Data discussed according to principal drainage basins: Washington coast; Puget Sound; Lower, Middle, Upper

Columbia R.; Snake R.; Yakima R.; and Coulee region. Includes cost est. of basin dams and reservoirs according to purpose served; summary of silting data re major reservoir projects therein; summary of other sedimentation data definitely related to reservoir silting; and conclusion as to probable silting extent. General reservoir silting rates not high in Wash. because one or more of following conditions usually exist at nearly every major one: (1) reservoir is raised natural lake; (2) reservoir off-channel, permitting certain amt. of sediment-control; (3) ratio of storage capac. to watershed area high; or (4) sediment production per drainage area unit low due to well forested condition of watershed. Highest silting rate found in Condit Reservoir on white Salmon R. in middle Columbia R. basin due to low capac. watershed ratio rather than to high erosion rate therein. Highest annual sediment production rate per drainage area unit in state, as detd. by suspended-load measurements, at moderate rate of 62.4 acre-ft./100 sq.mi., occurring on watershed of Mo. Flat Creek, tributary to S. Fork at Palouse R. Highest sediment production rate per drainage area unit as detd. by reservoir deposits, found above Tieton Reservoir on Tieton R. in Yakima R. basin, but because of extremely high-capac. watershed ratio, silting rate very low. Summary of existing suspended-load data for Wash. streams indicates avg. sediment production per drainage area unit generally very low in state when compared with rates found in other parts of U.S. In some parts of state, large quants. of sediment carried by glacial-origin streams on western slopes of Cascade Mts., in Puget Sound basin and by those flowing across Colee region. Sediment control measures incorporated in designs of major projects on cascade streams and difficulties largely overcome, but at considerable cost for installation and operation. In Coulee region, sediment trapped and used for agric. purposes; therefore, not considered detrimental. In various parts of state, serious soil erosion exists but believed sediment contributed has not caused high silting rates in major reservoirs, few of which located below such areas.—*Ralph E. Noble.*

Notes on Reservoir Silting and Suspended-Load Measurements in Idaho. L. C. Gottschalk. U.S. Dept. Agric., Soil Conserv. Service, Special Rpt. No. 4 (Jan. '43). U.S. storage reservoirs vital in indus. and agric. war production, supply half war production centers, ⅓ of nation's power and much irrigation. In many sections, accelerated soil erosion sabotaging these reservoirs. More than **$100,000,000** spent in Idaho on dams and storage reservoir constr. Reservoir and silting data discussed according to principal drainage basins of Upper Columbia, Clearwater, Salmon, Lower Snake, Upper Snake, Owyhee and Great Salt Lake Rivers. Available data on silting of Idaho reservoirs insufficient for comprehensive conclusions as to extent of damage by principal drainage basins, or for adequate ests. of probable silting rates in proposed reservoirs. Detd., however, that certain areas of high sediment production do occur and that reservoirs on streams draining them likely to lose capac. rapidly, especially under low capac.-watershed ratio. Mining operations, depletion of vegetal cover by burning, logging, overgrazing on steep slopes with loose soils and, in limited areas, cultivation, principal factors causing accelerated erosion and increased sediment. Principle existing storage developments in Idaho located in Upper Snake R. basin and, if heavy reservoir silting occurs, would assume greater importance in this basin than in others of state. Anal. of published and unpublished data for Idaho indicates in many cases high percentage of total sediment loads of streams in this region transported as bed load. Any ests. of reservoir silting rates based on suspended-load measurements only, probably much too low unless amt. of bed load carried into river properly considered.—*Ralph E. Noble.*

The Exchange of Dissolved Substances Between Mud and Water in Lakes. C. H. Mortimer. J. Ecol. **29:** 280 ('41); **30:** 147 ('42). Describes investigation of seasonal changes in hypolimnion and bottom mud of lakes and mechanism controlling release of nutrient materials to water. Study made of compn. of water and phys. conditions at water-mud interface in Esthwaite Water. After thermal stratification developed, concn. of D.O. and oxidation-reduction (redox) potential in bottom sample fell, and alky., conductivity, color, turbidity and contents of iron, silica, phosphorus and ammonium increased; nitrates decreased and nitrites appeared. Overturn in Oct. resulted in immediate rise in content of D.O. in lower layers of water and decrease in alky. and concns. of iron, silica, phosphorus and ammonium.

Some weeks before content of nitrate increased. When lake covered with ice, similar changes observed though developing more slowly than in summer. Suggested that when concn. of D.O. fell to limiting value, colloidal ferric ppts. in surface of mud reduced and ferrous ions and adsorbed bases liberated. Removal of barrier formed by oxidized surface of mud led to relatively unimpeded exchange of solutes between mud and water. After overturn, gradual fall in alky. may be attributed to selective adsorption of bases by reconstituted oxidized surface of mud. In lab. expts. mud-water systems examd. under aerobic and anaerobic conditions. In aerated tanks, layer of oxidized mud gradually increased in thickness; layer bounded by isovolt $E_7 0.24\,V$ (redox potential at which D.O. disappears). Not very much variation in compn. of water or mud. In anaerobic tank layer of oxidized mud disappeared after 40 days and redox potential of lower layers of water fell below $E_7 0.24\,V$; changes in compn. of water similar to those observed in Esthwaite Water. Lowest redox potentials at which various oxidized compds. could be detected detd. Survey next extended to Windermere in which complete de-oxygenation of hypolimnion does not occur. Changes in concn. of solutes at overturn definite but slight compared with those observed in Esthwaite Water; content of D.O. not sufficiently depleted to allow adsorbent oxidized layer of mud to be destroyed. Effect of wind in inducing oscillatory movements of water sufficient to cause turbulence in hypolimnion discussed. If, as result of evolutionary or cultural changes in lake, conditions become such that surface layers of mud reduced, productivity of lake may be expected to increase suddenly, owing to increased liberation of nutrient materials from mud. Bibliography appended.—*W.P.R.*

Evaporation From Lakes and Reservoirs. F. Meyer. Minn. Resources Com. (June '42). Largest element of uncertainty in meteorological data used appears in wind veloc. First necessary to reduce wind velocs. observed at several Weather Bureau Stations under gradually changing conditions of exposure and height of anemometer to reasonably homogeneous set of observations at some one elevation. Knowing mean wind veloc. used in making evapn. computation, familiarity with exposure of anemometer permits modification of computed evapn. by introducing new wind veloc. into formula: $1 + \frac{W}{10}$ and correcting evapn. accordingly [W = wind veloc. in mph.]. In this evapn. study, Meyer formula: $E = C(V_w - V_a)\left(1 + \frac{W}{10}\right)$ used, in which: E = evapn. in in. depth; V_w = max. vapor pressure in in. of mercury; V_a = actual vapor pressure, in in. of merucy; and C = an empirical const. (or evapn. coef.) dependent upon time, size and character of body of water. Water temp. most signif. single factor in detg. evapn. loss. For every 18°F. increase in temp. elastic pressure of water vapor practically doubles. Evapn. varies with temp. at substantially same rate. Although not safe to generalize from few records, indications are that, in South, particularly in arid Southwest, water temp. avgs. somewhat lower than air temp., whereas in North water temp., during open season, avgs. higher than air temp. Rapid radiation into dry atmosphere at night and high heat loss through evapn. in arid regions may cause lower water temp. Correction to be applied to vapor pressure, for changes in height of thermometers above ground not same in Upper Mississippi Valley, for example, as in Lower Mississippi Valley. Lowest mean annual vapor pressure observed at any long-term Weather Bureau Station in U.S. 0.138" at Tonopah, Nev., altitude 6090'. Although energy required for evapn. of water supplied by solar radiation, appreciable lag between cause and effect. Some investigators believe that evapn. loss from lakes and reservoirs can readily be detd. directly from solar radiation by means of heat-balance equation. Author of opinion that from practical aspect of evapn. from lakes and reservoirs we are not much concerned with thin laminar layer immediately above water surface because almost invariably sufficient wind to cause turbulent mixing. Wind veloc. has substantial effect on evapn. loss through turbulent mixing of air. On the whole, highest wind movement shown in region of Great Plains. Closely related to wind factor is evapn. coef. Coef. of 11 appropriate for computing evapn. from small lakes and reservoirs. Large local variations in climatic factors affecting evapn. in West well illustrated by available Weather Bureau data for region around San Francisco. During past 3 yr. daily evapn., computed with Meyer formula, checked against observed water losses from Lake Minnetonka, Minn. Monthly and annual evapn. from

lakes and reservoirs in U.S. presented in form of maps, graphs and tables, for use in design, constr., operation and maint. of works for using water.—*H. E. Babbitt.*

Construction and Management of Distant Water Supplies From Valley Dams. W. WIEDERHOLD. Gas-u. Wasser. (Ger.) **85:** 345 ('42). Economic and financial aspects of a system of water supply from impounding reservoirs at distance discussed. Technical aspects of problem dealt with under following heads: hydraulics of supply of water over long distances; choice of route; calcns. relating to pipeline from reservoir; pipes and materials for their constr.; measuring app. of various kinds; reservoirs; qual. of water; safety measures and future developments. Qual. of water in system in Harz mts. described. Water filtered, rate of passage through filters being 4–5 mph. Bact. count varies little and no *Esch. coli* found when samples of water incubated at 37° and 46°. Treatment of filtered water with chlorine and ammonia prevents any after-growth of bacteria even in distant parts of distr. system. Temp. of water varies little, as it gradually acquires temp. of soil as it passes through 200-km. pipeline from reservoir. Water treated with lime water until pH value obtained at which all CO_2 converted to bicarbonate and part of bicarbonate formed changed to carbonate. This deg. of neutralization proved satisfactory, although 2° (Ger.) carbonate hardness, thought in gen. to be necessary, not attained. Effect of waters on different types of pipe discussed.—*W.P.R.*

The Action of Bentonite Clay in Stopping Leaks in Water Supply Reservoirs. ANON. Can. Engr.—Wtr. & Sew. **81:** 2: 14 (Feb. '43). Bentonite clay, natural hydrous silicate of alumina, usually contains 30–40% moisture. For commercial use, moisture reduced to 7% and clay then powd. or granulated. Inert, except for slight alky., contains only occasional traces of org. matter and can be dried and re-swelled, without limit, at temp. not exceeding 450°F. At full satn., vol. as much as 15 times dry bulk. This swelling property dets. effectiveness in stopping leaks. For treating earth dams and reservoirs, etc., bentonite usually employed in dry form, either by itself or mixed with soil or sand. In most cases, 4" depth of mixt. contg. 10% bentonite, well packed, sufficient to elim. or greatly reduce seepage. Amt. required may be detd. by observing effect of admixtures on percolation of water through soil in question contained in pail with perforated bottom. Safety factor of 25–100% should be allowed. Required amt. of bentonite may be incorporated in surface soil by discing, harrowing or raking, followed by rolling or tamping; or bentonite may be added to other soil to be used as surface dressing. Alternative method to treat surface with bentonite and then with 3–4" layer of earth. When desired to treat reservoir without draining, crushed bentonite sprinkled on surface of water. Sinks to bottom forming gel, sealing leaky crevices. Whole area may not need treatment. In lab., 1 lb. will seal 3–4 sq.ft. permeable sand, but in practice 1 lb. per sq.ft. recommended. Bentonite also employed for sealing leaking gas mains.—*R. E. Thompson.*

Influence of Bird Life Upon Reservoirs. ERIC HARDY. Wtr. & Wtr. Eng. (Br.) **45:** 113 (Sept. '42). At some reservoirs "gull scares" fitted up to fire blank cartridges at intervals to keep birds off water. No evidence, however, that birds ever contamd. any water supply. Most noticeable influence of bird life introduction of weed, most common of which water thyme distributed throughout country during past century by water birds. Often contended there is much in common between migrant bird life visiting sewage farms and visiting reservoirs. Wild duck less likely to travel between these places. Distr. of many aquatic plants depends entirely on water fowl. Common water hen frequently changes abode and transports pond weed on feet. Thompson found 4500 seeds in British mallard, and Newstead another contg. 300 to 400 seeds of cleavers. Nesting pop. of avg. reservoir not big, owing to depth of water, but visiting pop. suprisingly numerous. Some shallower reservoirs, holding water for canals, support numerous nesting pop. of great crested grebes, coot, wild duck, dab chicks, tufted duck, etc. *Discussion. Ibid.* **45:** 159 (Oct. '42). GEORGE BAXTER: Exception must be taken to statement that bird flocks never contamd. any water supply. Activities of sea birds unfortunately not confined to bathing. Sea gulls responsible for much objectionable poln. of public water supplies. Results obtained in investigation into effects of gull poln. on reservoir of approx. 80-mil.gal. (Imp.) capac. showed that during summer *Esch. coli* not infrequently absent in 100 ml. in impounding reservoir, but in service reser-

voir almost invariably present in 5 ml. and, on occasions, in 1 ml. When 0.25 g. of gull excreta shot on reservoir added to 2000 ml. of sterile water, pos. reaction for *Esch. coli* obtained in 0.01 ml. On immersing gull from reservoir in 6000 ml. of sterile water, pos. reaction obtained in 0.01 ml. Gelatin cultures showed large no. of organisms were of liquefying type. Concluded that in 24 hr., 500 gulls could contam. a 100-mil.gal. reservoir to extent of giving pos. reaction for *Esch. coli* in 8 ml. of water. In this particular case, gulls had only some 3 or 4 mi. to fly from outlets of city sewers. *Author's Closure. Ibid.* **45:** 198 (Nov. '42). In case of gulls and reservoirs, fact that no reservoir, to author's knowledge, prove to have been contamd. by gulls through natural course of events probably due to other factors neutralizing possibilities shown in lab. work.—*H. E. Babbitt.*

HEALTH AND HYGIENE

Explosive Epidemic of Sonne Dysentery. C. A. Green & M. C. MacLeod. Br. Med. J. *No.* 4312: 259 (Aug. 28, '43). Find no recorded instance of epidemic in which possible water-borne *Shigella dysenteriae* Sonne infection subsequently supported by lab. evidence. In first week of outbreak, at least 200 cases; in first mo. 400 out of 10,000 pop. Milk or water common source suspected. Fortunate isolation of *S. dysenteriae* Sonne from water sample precluded sampling error possibility. Disturbingly, water sample satisfied usual purity stds. and showed 0.15 ppm. residual Cl_2. Experimentally found above organism survived chlorine-ammonia ratio of 2 : 1. Accordingly, amt. increased to give 0.4 ppm. residual Cl_2. At same time chlorine-ammonia ratio increased to 4 : 1. Thereafter but few dysentery cases occurred, usually giving history of contact with previous case. Apparent linkage of onset to milk found due to fact one dairyman rinsed steam-sterilized milk bottles with cold tap water. Fly-borne infection ruled out.—*Ralph E. Noble.*

Non-Industrial Absorption of Lead From Drinking Water; Its Clinical Importance, Social-Political Danger and Prevention. W. Kollath. Muench. Med. Woch. (Ger.) **89:** 44: 927 (Oct. 30, '42). Lead poisoning only recognized as compensatable disease when some or all of classical symptoms—"blue line," palsy, colic, encephalopathy, etc.—present, but latent danger of non-indus. lead poisoning shown by epidemics of illness in which many cases remain unrecognized or wrongly diagnosed. Lead present in ash of human bones in amts. of 0.06–0.25 mg. in 3 g. of ash, usually regarded as "normal." This derived chiefly from drinking water; early morning water in various German towns found to contain varying amts.—from 0.14 to 1.6 mg./l. Injuries caused by repeated small doses of lead not easily recognizable but lead a reducing agent which injures cellular respiration and its effect on calcium and phosphorus metabolism important; calcium admin. may cause mobilization of lead deposits in bones and therefore increase amt. in circulation. Author considers that predisposition to lead poisoning may exist similar to "prerachitic" state in rickets. Recognizable symptoms of lead poisoning only occur when lead in circulation has given rise to tissue injury. Injury of vessel walls—fatty degeneration and swelling of endothelium—causes narrowing of lumen and consequent rise of blood pressure. Further increased by disturbance of metabolism of smooth muscle by reducing action of lead. Injury of involuntary muscle of intestine causes spastic condition with obstinate constipation and lead colic in severe cases. In absence of classical symptoms of lead poisoning suspicious early signs include constipation, raised blood pressure, loss of sex fertility, punctate basophilia and increase in no. of basophil leucocytes. These exemplified in case described of husband and wife occupying first floor of a villa where lead pipe 15 m. long led to kitchen. Husband's early symptoms—constipation, intestinal spasm, lassitude and coldness in left side of abdomen diagnosed as "diverticulitis" and "mucous colitis." After 4 yr. he developed peroneal paralysis and punctate basophilia. Wife suffered from pain in left side and back and severe constipation; marriage was childless. Drinking water contained 5 mg./l. of lead. Author states that such "abortive" cases not rare, and that present danger of lead poisoning arises from increased lead intake from drinking water combined with increased susceptibility to lead poisoning inherent in modern civilization.

For prevention recommends that lead pipes for drinking water should be forbidden by law, with possible concession that last 10 cm. leading to tap may be made of lead.—*B.H.*

Sulfanilamide Activity Against *Escherichia coli* Under Anaerobic Conditions. C. E. CLIFTON & ISOLDE E. LOEWINGER. Proc. Soc. Exptl. Biol. & Med. (Br.) **52:** 225 (Mar. '43). Study shows that sulfanilamide inhibits respiration and growth of *Esch. coli* in synthetic medium with glucose as source of energy under either aerobic or anaerobic conditions and that *p*-aminobenzoic acid also exerts its anti-sulfanilamide activity under aerobic conditions. Growth and respiration inhibited somewhat to same extent as for *Streptococcus pyogenes* and Type I *Diplococcus pneumonae.* Sulfanilamide appears to inhibit respiration somewhere between original dehydrogenase system and the final H-acceptor, possibly inhibiting H-carrier system. Not evident whether decreased rate of respiration due to growth inhibition or vice versa although Wyss reports respiration inhibited by sulfanilamide isomers not showing "chemotherapeutic" activity.—*Ralph E. Noble.*

The Prevention of Schistosomiasis Under Campaigning Conditions, Especially the Provision of Washing and Bathing Water Free From Cercariae. Johann-Friedrich Braune. Deutsch. Trop. Z. (Ger.) **46:** 409 ('42); Trop. Diseases Bul. **40:** 252 ('43). 2 following Cl prepns., both available in powd. or tablet form and stable and readily sol. in water, shown to be effective against cercariae in water: (**I**) Clorina, previously called Hydrosept, chloramine prepn. (*p*-toluenesulfonchloramide of Na), contg. 25% active Cl and (**II**) Caporit (Ca hypochlorite), contg. 70–75% active Cl. Both **I** and **II** tested in Hamburg tap water and in dirty water of Elbe against cercariae of *Schistosoma mansoni* obtained by exptl. infestation of *Planorbis guadeloupensis* in Hamburg Tropical Inst. Made little difference whether tap water or Elbe water used, although cercariae died rather more quickly in chlorinated Elbe water. Stirring helps lethal action. All expts. done at 20–24°; at 29–30°, nearer tropical temps., no significant difference in times required to kill cercariae noticed. Following work of Klepetars, acid added to hasten action of **I.** Citric and tartaric acids employed, since shown experimentally that in concns. used these acids did not damage cercariae. In practice, HCl or other cheaper acids could be used. Results same with both citric and tartaric acids. **I,** in concn. of 1 g./10 l. Elbe or tap water, with addn. of 1 g. citric or tartaric acid, killed all cercariae within 10 min. Same result followed when 0.5 g. **I** with 2 g. citric or tartaric acid used; for former better because uses less solid material and gives added safety of Cl content twice as high. If acid left out, substantially longer time required (0.5 g. **I** in 10 l. than required 125 min.). **II** has higher Cl content and works as well in weaker solns.; 1 g. **II** freed 100–200 l. tap or Elbe water within 10 min. and 200–500 l. within 15 min. Action did not begin to fall off until sixth day. Requires no acid; thus more useful for larger quants. of water. Tablet of 0.1 g. enough for bucket or basin (capac. calcd. as 10–12 and 4–6 l., resp.). All expts. done in glass vessels and probably apply to basins, baths and other containers with solid walls, but collections of water in open not tested; in these vegetation, bacteria and org. matter would probably reduce action of Cl. Neither **I** nor **II** in relatively strong solns. (1 g. **I** and 1 g. citric acid in 10 l. water or 1 g. **II** alone in 100 l.) could kill *Bulinus contortus,* intermediate host of *S. haematobium,* or an unidentified species of planorbis after 18 hr. Seitz filter layers in German Army knapsack filter cannot be penetrated by cercariae. Dangers of infection when using filter or when cleaning it pointed out. Concn. of both **I** and **II** which will kill cercariae will also kill bacteria in drinking water.—*C.A.*

Distribution of Health Services in the Structure of State Government. Chap. IX. *Central State Services Affecting All Branches of Public Health Work.* JOSEPH W. MOUNTIN & EVELYN FLOOK. U.S. Pub. Health Rpts. **58:** 249 (Feb. 12, '43). As part of text, authors discuss pub. health lab. services. State maintains pub. health labs. for 3 major purposes: (1) to make available, to physicians, hospitals and pub. health personnel, diagnostic facilities otherwise unavailable; (2) to prep. certain biologicals to be distributed for preventive or therapeutic purposes; and (3) to provide personnel acting in supervisory capac. re practices and procedures of private labs. To varying extents and under divergent circumstances, provision of lab. service for diagnosis of communicable and noncommunicable diseases, for anal. of drinking water, milk foods and drugs, and for detg. presence and concn. of toxic substances in indus. establish-

ments recognized as responsibility of state govt. Important function of state health dept. labs. is bact. and chem. anal. of drinking water samples. Water lab. may be part of diagnostic lab. or operated separately by div. of san. eng. Water samples collected periodically from pub. supplies, but samples from private ones usually tested only upon request of local physician, pub. health worker or private citizen. More customary for state agency to charge fee for water anal. than for any other type of lab. service. In addn. to health dept. activity, several state universities, either independently or co-operatively, with dept., also make drinking water anals. *Health Education*. Two major objectives—training for professional personnel and dissemination of health information for general public. Sometimes state and local health depts. employ personnel without adequate specialized training. When such personnel otherwise basically satisfactory, most state health depts. arrange leave of absence and pay considerable portion of higher education costs in accredited schools. To large extent, federal grants-in-aid utilized. Training funds devoted to tuition, stipends and for travel expenses of selected personnel. Proportion of applications from sanitation personnel relatively low compared with physicians and nurses. Possibly due in part to lack of appreciation by pub. health administrators of advantages from training this class of personnel. Addnl. factor, however, fact that many sanitarians, excluding engrs., deficient in educational qualifications for work in graduate school of pub. health; hence training of informal type. Addnl. education provided for sanitation personnel, therefore, more apt to be given through in-service than academic training. Fewness of lab. technicians given post-graduate training ascribed to fact their basic instruction involves higher deg. of specialization than broader fundamentals of nurses and physicians. *Expenditures for Central Office Services Affecting All Branches of Pub. Health Work*. In part, noted that while few states accredited less than 20% to either lab. service or licensure, lab. activities received from 20–40% in half states, and more than 40% in only 16.—*Ralph E. Noble.*

Hyperion Beach Pollution Survey Reveals Dangerous Condition. ELMER BELT. Western City **18**:11:28 (Nov. '42). Survey of poln. of Santa Monica Bay beaches by sewage from Los Angeles Hyperion plant in progress. Flowing through plant, 1 mil.cu.ft./hr., sewage filtered through large drum-screens then discharged through concrete submarine outfall approx. 5000′ off shore in 60′ water. Many yr. plant too small for peak load while 2 large leaks in outfall pipe at low-tide line 200′ off shore. Consequently, 20 mi. of Santa Monica Bay beaches subject to sewage poln. Politics and economics prevented proper action by Los Angeles before war added obstacle of vital materials procurement. Drum-screen openings, $\frac{3}{16}$″ diam. × 3″ long, allow 88–92% solids to pass. Beach filth described. Sewage often bypassed when frequent excess grease-flows plug screens or when heavy rains overload plant. Sewage grease and *Esch. coli* found on beach and in surf 8 mi. from outfall. Surf right over latter contains 100,000 to 1,000,000 coliform organisms per ml.; $1\frac{1}{2}$ mi. out, 1000; 3 mi. out, 250. Due to south wind, surf 8 mi. north at N. Santa Monica contains 24 to 110 per ml. 5 mi. of beach and surf immediately adjacent to outfall constantly contain large amts. of sewage grease and more than 100 per ml. at all times. Present survey obtained medical histories indicating paratyphoid fever, acute diarrhea and possibly sore throat contracted from pold. surf. Contamd. surf water now being tested for intestinal pathogens. Some medical men believe such pold. surf may transmit poliomyelitis. Pathogenic intestinal protozoans and other parasites survive as cysts in sea water.—*Ralph E. Noble.*

War Production Board—Office of War Utilities

Administrative Letters to All Utilities—J. A. Krug, Director

SUPPLEMENTARY UTILITIES ORDER U-1-d AMENDED

SUPPLEMENTARY Utilities Order U-1-d, as amended December 10, 1943 (issued March 29, 1943), has minor changes in language, made to bring this order into line with other Supplementary Orders. In addition the following changes of substance have been made:

1. Limitations on the weights of material to be used in the construction of industrial and commercial extensions have been replaced by a statement of design standards in paragraph (a), so that, within the $500–$1500 ceiling on cost, now contained in paragraph (c), producers are not restricted as to quantity of material in building these extensions.

2. The substance of former Supplementary Order U-1-b, revoked concurrently with the issuance of amended U-1-d, has been incorporated in paragraph (b) (2), so far as it is applicable to the construction of extensions related to specifically authorized domestic remodeling jobs. As a result, a domestic consumer who has applied for and received authority to do remodeling may not obtain electric or gas service if that would entail the construction of a new gas or electric line which would duplicate an adequate cooking arrangement already in the house. This provision is, of course, not relevant to wholly new construction since in that case the dwelling being proposed for an extension will not be already equipped with a cooking range.

3. Reference is made specifically to Form WPB-3348 rather than to a letter, in the provision of paragraph (c) requiring a utility statement that extensions can be built within U-1-d limits. As you know, this statement is used by the Housing Agencies and War Production Board in determining whether authority for the consumer's building construction should be granted.

4. Two provisions regarding competitive construction which have become standard in supplementary orders have been added as paragraphs (c) (3) and (c) (4).

5. A reference to the natural and manufactured gas limitation orders, U-7 and L-174, has been incorporated as paragraph (d).

SUPPLEMENTARY UTILITIES ORDER U-1-d AS AMENDED DECEMBER 10, 1943

Section 4500.5. *Supplementary Utilities Order U-1-d* is hereby amended to read as follows:

§ 4500.5 *Supplementary Utilities Order U-1-d.* Notwithstanding the provisions of paragraph (h) (1) of Utilities Order U-1, extensions of electric, water, gas, and central steam heating facilities may be made or connected by producers to serve premises, the construction or remodeling of which is authorized under Conservation Order L-41 by the issuance of a specific direction, order, certificate, or other authorization for construction, when all of the following conditions are satisfied:

(a) *Industrial or commercial consumers.* The extension is designed to use the smallest sizes and quantities of equipment, conductor, and pipe required to furnish service at minimum standards.

(b) *Domestic consumers.* (1) The extension, including any part built by or for the consumer, can be built within the limits established by the Housing Utilities Standards issued by the War Production Board.

(2) In the case of gas or electric facilities primarily to serve cooking appliances, (i) the dwelling proposed for connection is not equipped with a range of any kind; and (ii) complete facilities to a cooking range location are not installed for serving either a gas range or an electric range, except that extensions to serve a gas or electric range which the consumer has used in a dwelling which he previously occupied may be made even though facilities for serving another type of range are already installed.

(c) *All consumers.* (1) The total cost of material for each extension, exclusive of any part built by or for the consumer, does not exceed $1500 in the case of underground construction or $500 in the case of other construction. No job or project may be subdivided to come within these limits.

(2) No other producer can render the same service with lesser amounts of critical material.

(3) The extension does not duplicate an adequate service already installed or constitute a standby service.

(4) The producer has completed Form WPB-3348 for filing with the builder's application under L-41.

(d) *Other orders.* This order does not constitute a release, in the case of gas producers or consumers, from the restrictions of Utilities Order U-7 or Limitation Order L-174.

Issued this 10th day of December 1943.

WAR PRODUCTION BOARD,
By J. JOSEPH WHELAN,
Recording Secretary.

Administrative Letter to All Utilities—J. A. Krug, Director

SUPPLEMENTARY UTILITIES ORDER U-1-f AMENDED

Supplementary Utilities Order U-1-f, was amended December 10, 1943. The following changes of substance have been made:

1. The provision of former paragraph (b) (2) which prevented the construction of gas and electric extensions to domestic consumers except in the localities listed in Schedule A, has been removed from the order. Schedule A has also been deleted. There is now no geographical restriction on the permission granted in U-1-f.

2. The substance of former Supplementary Order U-1-b, revoked concurrently with the issuance of amended U-1-d, has been incorporated in paragraph (b) (2). As a result, an extension of gas or electric service may not be made under U-1-f if an adequate cooking arrangement has already been made in the building to be served.

3. The class of industrial and commercial consumers who may be served under U-1-f has been enlarged by the addition to paragraph (b) (3) of certain other industries.

4. A reference to the natural and manufactured gas limitation orders, U-7 and L-174, has been incorporated as paragraph (c).

5. Extensive revisions of Schedule I (formerly Schedule B) are designed to simplify the Utilities Construction Standards, to encourage the use in construction authorized by the order of sizes and types of wire now idle in excess inventories, and to reflect changes in the supply of pipe. Please review Schedule I carefully since there are numerous and detailed changes made in this revision.

SUPPLEMENTARY UTILITIES ORDER U-1-f AMENDED DECEMBER 10, 1943

§ 4500.7 *Supplementary Utilities Order U-1-f*—(a) *Definitions.* For the purposes of this supplementary order:

(1) "Domestic consumer" means a prospective consumer who is requesting an extension of service to a building used exclusively for dwelling purposes.

(2) "Industrial consumer" means a prospective consumer who is requesting an extension of service to a building used in whole or in part for the manufacture, processing or assembly of products or materials.

(3) "Commercial consumer" means a prospective consumer not classified in this order as "domestic" or industrial."

(b) *Permission to build certain extensions.* Notwithstanding the provisions of paragraph (h) (1) of Utilities Order U-1, extensions of electric, water, gas, and central steam heating facilities may be made or connected by producers when all of the following conditions are satisfied:

(1) Where construction or remodeling by the consumer is involved, no specific direction, order, certificate or other authorization for construction has been issued by the War Production Board to authorize such construc-

tion or remodeling. If such authorization has been issued, the construction of utility facilities is governed by Supplementary Utilities Orders U–1–d or U–1–h.

(2) In the case of gas or electric facilities primarily to serve cooking appliances, (i) the dwelling proposed for connection is not equipped with a range of any kind, and (ii) complete facilities to a cooking range location are not installed for serving either a gas range or an electric range, except that extensions to serve a gas or electric range which the consumer has used in a dwelling which he previously occupied may be made even though facilities for serving another type of range are already installed.

(3) In the case of facilities to serve industrial or commercial consumers, the consumer (i) is engaged in the manufacture of a product or in the conduct of a business or activity listed in Schedules I or II of CMP Regulation 5, as amended; or (ii) is an electric, water, gas, steam heat, telephone or telegraph utility; or (iii) is engaged in the petroleum industry, except in retail marketing, as those terms are defined in Preference Rating Order P–98–b; or (iv) is engaged in the business of mining, or of burning refractories, and has been assigned a serial number under Preference Rating Order P–56; or (v) is engaged in the business of radio communication or radio broadcasting; or (vi) is a school, church, or hospital.

(4) Extensions can be built within the limits of the Utilities Construction Standards, shown in Schedule I of this order, including any part built by or for the consumer.

(5) The total cost of material for each extension, exclusive of any part built by or for the consumer, does not exceed $1500 in the case of underground construction, or $500 in the case of other construction. No job or project may be subdivided to come within these limits.

(6) No other producer can render the same service with lesser amounts of critical material.

(7) The extension does not duplicate an adequate service already installed or constitute a stand-by service.

(c) This order does not constitute a release, in the case of gas producers or consumers, from the restrictions of Utilities Order U–7 or Limitation Order L–174.

Issued this 10th day of December 1943.

War Production Board,
By J. Joseph Wehlan,
Recording Secretary.

Note: Schedule A deleted: former Schedule B redesignated Schedule I and amended Dec. 10, 1943.

Schedule I—Utilities Construction Standards

The material used in extensions permitted by Supplementary Utilities Order U–1–f must conform to the limitations set out in this Schedule I and must not exceed, in dollar value, the limits of paragraph (b) (5).

A. PERMITTED TYPES OF CONDUCTOR AND PIPE

I. *Domestic extensions.* a. *Electric conductor for primary, secondary, and service drop:*

(1) Any type or size of conductor having conductivity equal to or less than that of No. 6 AWG copper, or

(2) Any type or size of conductor which can be obtained from the excess inventory of any producer.

(b) *Pipe:*

(1) For mains over 4″ in diameter (i) cast iron or non-metallic pipe or (ii) steel pipe in cases where installation conditions, high working pressures, or danger of breakage or leakage make the use of a substitute material impracticable or dangerous.

(2) For mains 4″ in diameter and smaller and all service connections, any type of pipe.

II. *Commercial and industrial extensions.* No limitation, except as shown below in B, II.

B. PERMITTED QUANTITIES OF CONDUCTOR AND METALLIC PIPE

I. *Domestic extensions.* a. *For electric service,* not more than 1,000 conductor feet, including primary, secondary, and service drop.

b. *For gas or central steam heating service,* not more than (1) 400 pounds of steel pipe or 1800 pounds of cast iron pipe, or (2) a combination involving not more than 400 pounds of steel pipe and not more than 1800 pounds of cast iron pipe, this quantity of cast iron pipe to be diminished by twice the weight of steel pipe used.

c. *For water extensions,* not more than (1) 400 pounds of steel pipe or 1800 pounds of cast iron pipe or 1,000 pounds of lead or lead alloy pipe, or (2) one of the following combinations:

(1) 400 pounds of steel pipe and not more than 1800 pounds of cast iron pipe, this quantity of cast iron pipe to be diminished by twice the weight of steel pipe used. In addition, a lead goose-neck is permitted.

(2) 1,000 pounds of lead or lead alloy pipe and not more than 1800 pounds of cast iron pipe, this quantity of cast iron pipe to be diminished by the weight of any lead or lead alloy pipe used.

(3) 400 pounds of steel pipe and not more than 1,000 pounds of lead or lead alloy pipe, this quantity of lead or lead alloy pipe to be diminished by twice the weight of steel pipe used.

II. *Commercial and industrial extensions.* The smallest sizes and quantities of equipment, conductor and pipe required to furnish service at minimum standards.

C. PERMITTED QUANTITIES OF NON-METALLIC PIPE

Non-metallic pipe of a length not greater than that length which would be installed if cast iron pipe were used as permitted in B above.

Important Supplemental Occupational Deferment Ruling

NATIONAL Headquarters of the Selective System on January 5, 1944 announced that in the future Army, Navy, or other Government agency representatives in industries and plants may be asked, where production urgency requires, to make joint certification with employers as to the necessity of workers in such plants for whom deferments are sought.

The certification plan and procedures will be extended to industries and establishments where production urgency exists, however, only when the Director of Selective Service determines that such plans and procedures are required and the Army, Navy, or other Government agency concurs, Selective Service emphasized.

Similar procedures have been in effect in West Coast aircraft and parts plants since November 6 and today were authorized for approximately 15 plane and parts plants outside the California-Washington-Oregon area.

The plan and procedures provide for:

1. Certification by Army, Navy, or other Government agency representatives as well as by the employer that an individual registrant is necessary to production and should be deferred.

2. Certification by Army, Navy, or other Government agency representatives as well as by the employer that replacement schedules and the deferments requested in accordance therewith are required to meet production goals.

While the plan does not affect the authority and the responsibility of the local board in the classification of registrants concerned, certification by the Army, Navy, or other Government agency representative gives the local board additional information of the registrant's necessity, Selective Service said. Similarly, certification by an Army, Navy, or other Government agency representative gives helpful information to State Directors of Selective Service when they are considering acceptability of replacement schedules for the plants concerned.

The certification by an Army, Navy, or other Government agency representative is filed as a supplement to the Selective Service Request for Occupational Deferment (Form 42–A) in the case of an individual registrant and does not relieve the employer of the responsibility of filing a Form 42–A when requesting deferment of an employee.

[Plans are in development which will permit the Office of War Utilities to act as the "Government Agency," referred to above, in the case of essential employees in utility plants. The Water Division will relate itself to the cases of water works men, etc. The procedure has not as yet been formally outlined. When it has, advice will be conveyed to all A.W.W.A. members. *Harry E. Jordan.*]

Water Conservation in Long Beach, Calif.

SOME of the people who have studied the *Water Conservation* document released by the Association last Fall, have indicated they felt we had over-emphasized the possibility of reduction of waste in the water mains and water services.

From Long Beach, Calif., comes a record of efficient control of the water distribution system, which is so valuable it must be brought to the attention of the Association membership. The following, from a letter written by Mr. Walter M. Brown, Engineer Water Department, Long Beach, tells a story of water conservation of which any water works can be proud:

"The following is a fifteen year table of *unaccounted for water,* in percentages:

Yr.	%	Yr.	%	Yr.	%
1928–29	6.7	1933–34	5.8	1938–39	4.2
1929–30	6.5	1934–35	6.4	1939–40	3.2
1930–31	5.5	1935–36	5.5	1940–41	4.2
1931–32	5.3	1936–37	5.1	1941–42	4.1
1932–33	5.7	1937–38	3.3	1942–43	3.7

"The arithmetical average for the fifteen years is about 4.7 per cent.

"All of our wells are equipped with (Sparling saddle-type) main line meters on the discharge lines; and our use of water imported by the Metropolitan Water District of Southern California is metered both by the District and by ourselves. Until a few months ago, when meter deliveries began to slow up, our consumers were 100 per cent metered. Even now, we have only 600 flat rate services out of a total of 40,800, and these will be metered as soon as meters can be obtained.

"I used to question the accuracy of the mainline meters, believing that, in the light of our small percentages of water unaccounted for, they must be under-registering. However, at intervals of three to four years, we have the efficiencies of our well pumps tested under operating conditions, and almost invariably these tests prove the meters to be doing accurate work. When there is a material variance, it is just as apt to be in one direction as in the other. Consequently I decided, years ago, that we could not account for our low losses on the theory of under-registration of our pumpage.

"Our collection, transmission, and distribution system is first class. The low pressure collection system is 42 per cent cast iron and 58 per cent concrete. Our transmission system is 100 per cent cast iron. Our distribution system is 90.5 per cent cast iron, 4.7 per cent cement-asbestos and 4.8 per cent standard screw and other types of steel. And nearly 90 per cent of the steel is in the form of temporary 2 in. S.S. mains. Consequently, the system itself is about as leak-proof as you will find anywhere, especially when you consider our equable climate and lack of freezing weather.

"Unaccounted for water includes water lost or used in the following

ways: (1) Evaporation; (2) Main and Service Breaks; Other Leakage; (3) Fire Protection; (4) Flushing Mains and Hydrants; (5) Unauthorized Use; (6) A portion of the use of water by our own department; (7) Flat rate service use. Taking these up in order:

1. All the collection and distribution reservoirs are covered, and our climate is generally on the humid side; consequently evaporation losses are slight.

2. The soil conditions are such that, even in paved streets, leaks, even those relatively small, show quickly at the surface and are promptly detected and repaired.

3. The city has been very fortunate in the matter of fires. Our fire losses rank among the lowest in the nation, and are reflected in a small consumption of water for fire-fighting purposes.

4. While the department programs more or less systematic flushing of mains every year, especially dead end lines, the water required for this purpose is apparently not a very large amount, as most cities go.

5. Unauthorized use is kept at a minimum by the vigilance of meter readers and an occasional inspection of suspected areas.

6. The department has aimed at metering its own use of water, but certain uses are still unmetered. They include such items as water used in settling construction ditches, washing down reservoir walls, chlorinating new mains, etc.

7. Flat rate services are not tolerated when meters are available.

"Since Pearl Harbor we have equipped a number of cars and trucks with two-way short wave radios and have two emergency trucks so equipped and also equipped with mechanical valve closers by which we can close our largest gates (30 in.) in six to ten minutes, instead of the hour and more previously required to close them by hand. This equipment has cut down the losses from large main breaks, and if it were not for the temporary building up of unmetered services due to wartime restrictions, our total losses should show a further decline.

"We have sometimes thought that our system was unique in its small water losses. But upon commenting in this vein to Ray Sparling, of the Sparling Meter Co., sometime ago, he told us that there were a number of utilities in Southern California which could show maximum losses of 5 per cent or thereabouts."

Willing Water Says—

Have you ordered your copy of "Water Conservation"? This is a book prepared at the request of the Government to aid water works men in programs to assist the war effort. The advertisement opposite is one of a number available in various size mats for use in your local newspapers. Address inquiries to American Water Works Association headquarters.